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The "Third Step" Construction Is Described in This Issue

Volume 8 *Number 5*

MAY 1938

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Among Our Writers

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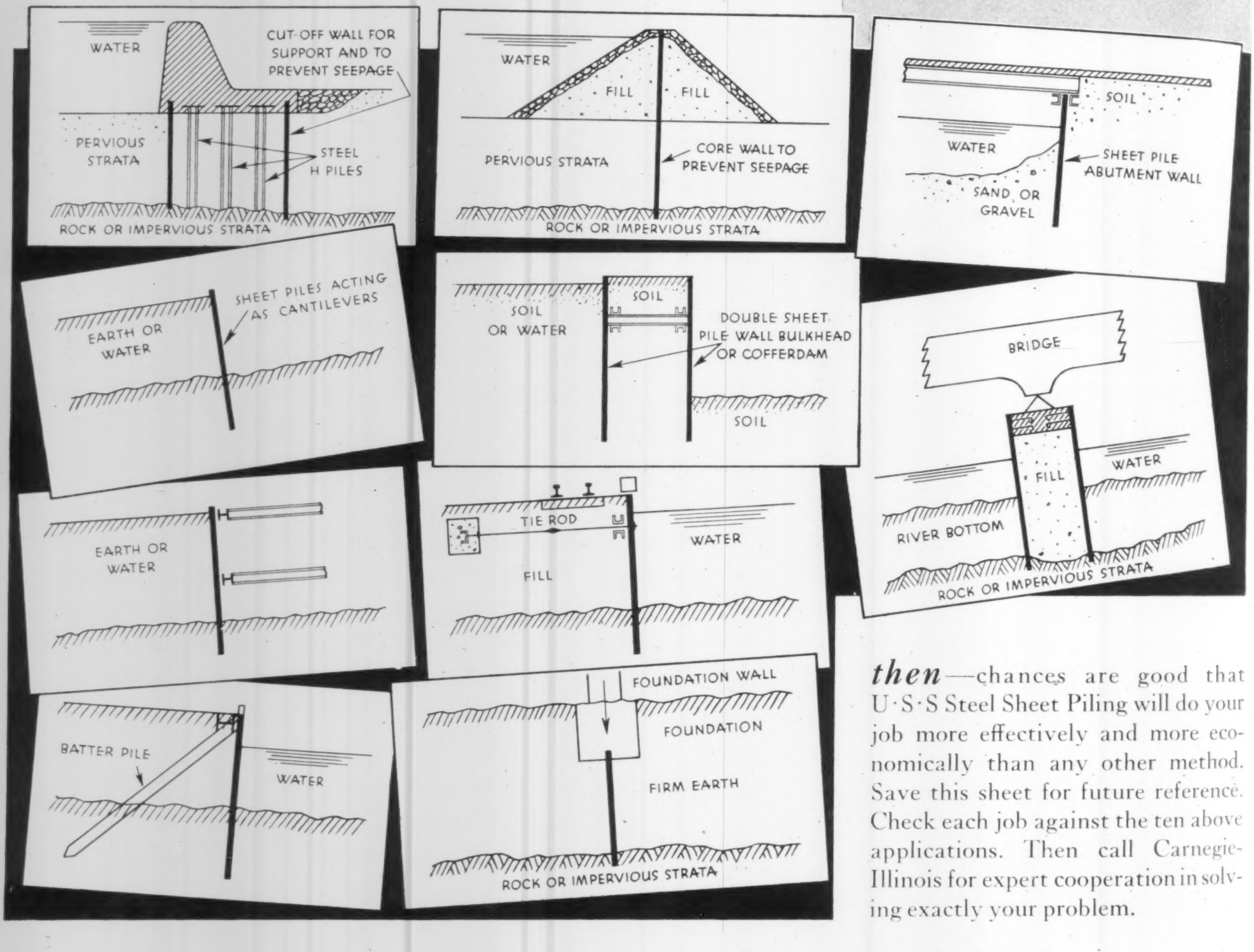
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ROCK OR IMPERVIOUS STRATA
EARTH OR WATER
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UNITED STATES STEEL

Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Engineering Among the Professions

By Roy E. McFee

In Engineering Department, Grand Trunk Western Railroad, Detroit, Mich.

BACK in the farming neighborhood of my boyhood days, I recall a land surveyor. He was a man of parts—he also taught the country school, and besides, being a retired clergyman, he occasionally filled pulpits in the local churches. In addition, he raised fruit on his small farm. A man of so many talents, he was universally respected, and invariably called upon whenever property rights were in dispute.

On a convenient day he would appear with his horse and buggy. Over along the edge of the clearing the compass would be set up. The oldest neighbors would offer their recollections as to landmarks. Eventually, through a nice combination of technical skill, woodsman's instinct, and mediation, a line would be established acceptable to all. He was indeed more than a surveyor. He was historian, arbitrator, and magistrate—protector of property rights in that community, and almost its court of last resort. And his like has never appeared in any other role.

A Dominant Part.∼In the broader fields of engineering, the engineer has been almost a monarch whenever he was on the frontier. There the bleak elements create emergencies, which only he could cope with. He built the western railroads and is rightly credited with conquering two-thirds of a continent. For example, undying fame has come to Eads who confined and bridged the mighty Mississippi, and to Goethals of our day, who completed the Panama Canal.

A backward view over the centuries reveals still a third situation in which the engineer has always been supreme. That is in the post of military leader. Indeed military science is itself engineering. Caesar and Washington were great generals because they were great engineers. Any portrait of Napoleon, even in the din of battle, shows the cool, calculating eye of the engineer.

Truly, engineering has not lacked for triumphs. Probably its story, if written by a master hand, would outshine all the other professions in glamour of achievement. Despite this, its glowing potentialities are not always evident to the professional engineer in his working world. An industrial age especially should be the first to acclaim the profession; yet many engineers feel that they are denied opportunities to which their abilities entitle them.

Credits as Well as Liabilities.∼Undoubtedly, the engineering profession has not yet attained full recognition. The quality of the individual engineer may have much to do with this. A contributing difficulty is that the engineer's monuments are not always labeled with his name. Too often his bridges bear witness to politicians more prominently than to the designer. It is true too that some individual engineers experience a lack of complete intellectual satisfaction in their work. There is a feeling, for one thing, that the man's whole abilities are not employed, that most of his liberal education and tendencies can be used only indirectly.

However, such shortcomings in a profession are always most apparent to its own members. The other person's work seems more attractive, if only because the satisfactions are more evident than the disappointments. For example, the law is rightly an admired profession. Yet the lawyer has been called a parasite, a non-producer, thriving on the troubles of mankind. On the average, he loses half his cases; in the courtroom he must reckon with the eccentricities of judges and the uncertainties of juries; and his highest honors often come through election or political appointment. There are similar limitations even in such leading professions as medicine and education.

But engineering has also its full measure of positive compensations, as every engineer knows. The list is impressive. To begin with, engineering offers unparalleled opportunities for specialization. There is a possible choice to fit almost any nature or inclination. Furthermore, engineering is always interesting and stimulating; it is an excellent training for a multitude of other vocations; and it can be the basis for business ventures. Engineering is indispensable to finance and industry. Its associations are with intelligent persons. The profession is honest, with high ethical standards.

Glorifying Mathematics.∼Gratifying progress has been made of late. A significant change of course is the inauguration of state board requirements in many states. This at least gives engineering a legal status on a par with the other professions. But how is the next advance to be made? Possibly it may come through self-evaluation and self-correction on the part of engineers. Three suggestions are here presented in all modesty.

First, engineering must glorify mathematics as never before. Mathematics anyway is the primary tool of the profession. The better that tool is, the better will be engineers and engineering. It is hardly an exaggeration to say that many engineers are not mathematicians at all. They simply know enough mathematics for ordinary purposes. For special cases they must search their handbooks and then use unfamiliar formulas with misgivings. Is it too much to expect an engineer to know and use spherical trigonometry and the calculus, and to have the mathematical fundamentals steeped into his very soul? Probably most of our notable engineers are mathematicians in a broader sense, but should not there be more?

More of our engineers might well choose a branch of mathematics and follow it to the end of the beaten trail. Mathematics for them would become the crown of their scholarship, a statement of reality far beyond the range of the ordinary mind. From it perhaps would be evolved a philosophy of engineering, corresponding to the position of jurisprudence in law.

But speaking more practically, the mastery of mathematics gives an exclusiveness in the engineering field. It does for engineering what anatomy does for medicine. Experience in the anatomical laboratory gives an awesome advantage too tremendous to be questioned. Likewise a mastery of mathematics leaves little to be feared. It gives an easy and assured superiority.

Engineers Their Own Spokesmen.~In the next place, for the engineer, language is probably second only in importance to mathematics. It little avails him to make an exhaustive investigation, unless he can write his report in compelling English. Indeed the quality of an engineer's English has been called an accurate measure of his professional possibilities. But even more important than his writing ability is his ability to make oral reports. The engineer should be capable of appearing in person before interested bodies. This means attention to a subject generally neglected. For of outstanding public speakers, the engineering profession has few indeed. Training might well begin in college and continue with additional courses or in professional societies.

In the field of engineering, the conception of the project and the preliminary investigation constitute the first step. And the final design and construction compose the third step. But as for the second step, it may be the presentation of the project to the public. The more the public is concerned in an engineering project, the greater is the engineer's responsibility to give that public reliable engineering information. He should possess the ability to address mass meetings, city councils, and legislatures, to obtain approval and authorization of sound engineering projects.

Incidentally, a few eloquent engineers could do much to strengthen the profession. No other benefits are quite so personal and immediate as those that come to the man who can face and command an audience and present his arguments clearly, forcefully, and interestingly. Emerson wrote, "Who can wonder at the attractiveness of Parliament, or of Congress, or the Bar, for our ambitious young men, when the highest bribes of society are at the feet of the successful orator? He has his audience at his devotion. All other fames must hush before his. He is the true potentate; for they are not kings who sit on thrones, but they who know how to govern."

A Great Objective.~Thirdly and finally, the engineer must have a cause to which he can give his heart and soul. It is not enough to build bridges of increasing span, to evolve materials of greater working stress, or to solve the growing problems of transportation. He must have a zeal for the right. The lawyer strives for justice and equity, under government and law. The physician has his ideal; it is health and relief from suffering. The engineer likewise must have a great goal.

But what should be his avowed aim? Should it be utility? Should it be the development of resources? Should it be the harnessing of natural forces for human service? It hardly seems so. All these are necessary tasks of the engineer; none represents his clear purpose in the scheme of things. It would seem that his inevitable objective in his service to man is nothing less than a careful trusteeship of the good earth. Into his keeping has been placed that from which all our wealth is taken and from which all our activities begin. His is a responsibility from which there is no escape. He is the appointed guardian of Nature's resources.

Thus he must be an economist. He must also be a moralist. But above all he must be a conservationist. He must look with a protecting eye on those natural resources which, although bountiful, are still definite and exhaustible. He must love the fertility of the soil, the mineral wealth in the earth, and the nation's forests and unspoiled beauty. Always he must urge conservation.

Future Holds Boundless Opportunity.~At the present moment the engineer is on the threshold of increasing prominence. One of the oldest of the major professions, it is also the newest in recognition. It is likewise the newest in its expansions and amazing specializations. For centuries it has been quietly meeting man's needs and wants, but if its magic springs are released, its development will be astounding. As President Nicholas Murray Butler of Columbia University has said, "The World is going to be turned over to the man with the engineering mind, training, and experience in the next one hundred years."

In the realm of public life, the engineer is already appropriating certain key positions. One of these is that of city manager, which has been his for a score of years. The engineer is also coming to be regarded as one of the chief custodians of public health. City planning, which is increasing in importance yearly, is likewise within his province. Great industrial corporations are turning to the engineer as manager of their far-flung properties and enterprises. Those same corporations are realizing a growing dependence on the engineer for their more specialized operations. Finally the engineer-economist is becoming the adviser of bankers and industrialists.

The physician heals; the educator teaches; and the lawyer adjusts human relations. But the engineer, for his part, will be called more and more to direct the mass efforts of his race. He is society's indicated master planner, its research worker seeking truth, and the conservator of its natural resources for coming generations. Is it not reasonable to believe that the increasing influence of the engineer may bring a degree of order and stability heretofore unknown in the world?

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NUMBER 5

The City Transit and Traffic Problem

Subways for Mass Transportation May Be Practicable Even in Cities as Small as 100,000 in Population

By ALFRED BRAHDY

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

NEW facilities for traffic may only add to congestion, says Mr. Brahdy, citing cases. He reviews the various means of city transportation in use today, pointing out the merits and disadvantages of each. Subways, he emphasizes, deserve more consideration than they are currently given. By considering them as alternatives to street-widening projects, they may reasonably be financed partly as a railway and partly as a street improvement.

MANY cities have made studies, reports, and plans for the solution of their mass transportation and traffic problems during the past three decades, but such plans have so seldom become a reality, in whole or in part, that the discrepancy between program and results calls for an analysis. The intensive utilization of land in cities by tall buildings is one of the major factors, and the extensive use of the private passenger automobile is another important factor, in creating a city transit and traffic problem of progressively increasing seriousness. This has been recognized by city officials, by engineers, by transportation operators, and by some civic bodies, but in most cities public apathy has prevented the inauguration of any comprehensive remedial action.

Transit and traffic requirements of the city and of interrelated communities which comprise a metropolitan district create situations wherein mileage loses its conventional meaning, so that the distance from residence to community center must be measured by transportation time. Under such conditions the several means of urban passenger transportation become items of utmost civic importance.

VARIOUS TYPES OF URBAN TRANSPORTATION

The suburban railroad, operated either primarily as such or as an adjunct to a trunk-line railroad, provides fast passenger service on a private right-of-way, to a terminal near the community center. Its disadvantages for city service are that stations must be several miles apart to maintain satisfactory schedule speeds, and that it cannot economically provide service at reasonably close intervals during the hours of light traffic. For most passengers, suburban railroad transportation means another ride or a walk from station to destination at each end, thus increasing the total travel time.

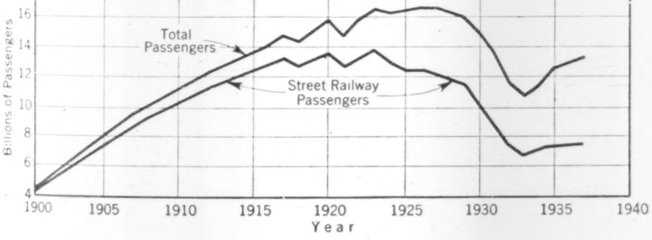


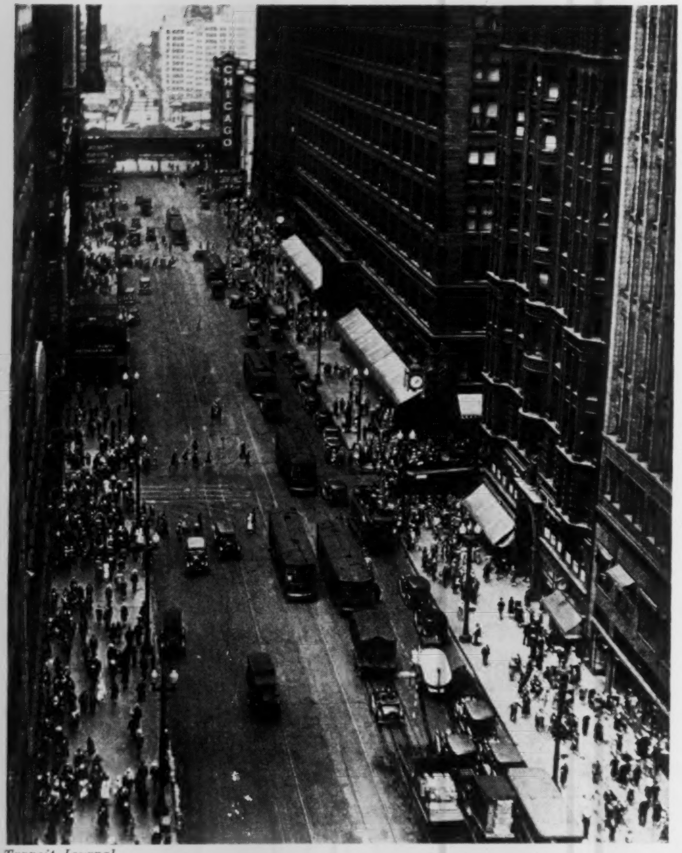
FIG. 1. CITY AND INTERURBAN PASSENGER TRAFFIC IN THE UNITED STATES, 1900–1937

Adapted from a Chart in *Transit Journal* for January 1938

The rapid-transit railway, operating on its own right-of-way, provides fast service between residential districts and a number of stations within the community center. While highly developed in a few cities—particularly New York, Philadelphia, and Boston—the use of rapid-transit railways is not general or extensive enough to warrant classing them as one of the major means of urban transportation.

Surface cars on public thoroughfares are the chief means of urban mass transportation (Fig. 1), as they bring passengers close to their destinations at a low cost per mile. Even in New York, which is preeminently the rapid-transit city of the world, they carried 564,000,000 passengers in 1937, as against 1,900,000,000 for the rapid transit lines. However, street-car transportation has its disadvantages. It is retarded in and near the community centers by other surface traffic; and it is further handicapped by the past sins of omission and commission in franchise restrictions, requirements for pavement maintenance, over-extensions, and bad financing.

The bus operating on city streets has greater mobility than the street car, but averages only about two-thirds the passenger load per vehicle per year. During peak traffic periods, when there are of necessity many standees, the spread in passenger-carrying capacity is still more favorable to the street car than the annual average indicates. Further, the bus generally carries a greater proportion of short-haul and casual traffic, while the street car is to a large extent used for rush-hour business traffic. It must therefore be apparent that any substantial displacement of street cars by buses in cities will increase the congestion within the already overcrowded community center—yet such displacement is now under way in an ever-increasing number of cities, particularly those in the 100,000 to 200,000 population range. Congestion can be relieved, of course, by fixing the bus stops several blocks apart or limiting them to terminals, but the convenience of near-to-destination stops is thereby lost.



Transit Journal

THE "BUSIEST CORNER IN THE WORLD"—STATE AND MADISON STREETS, CHICAGO

Liberal financing by the bus manufacturers, easy franchise terms, and specially paved streets aid bus operation and will permit low transportation rates as long as these favorable conditions continue. Curb stops, and new vehicles operating on streets specially paved for heavy traffic, make bus service attractive to passengers even though operation is not as smooth as is possible with rail cars. Bus operation requires more or wider roadways with heavy-duty pavements, all provided at the taxpayer's expense. Long hauls comparable to rapid-transit or suburban-railroad distances are possible for the bus, provided fares comparable to the mileage and commutation rates of the railroads are charged.

MANHATTAN'S EXPERIENCE WITH BUSES

In connection with the increasing use of buses for city transportation, the experience of the Borough of Manhattan of the City of New York is enlightening. For many years the only bus line was the one along Fifth Avenue, with branches through portions of uptown residential districts. The first subway, opened in 1904, was built under main thoroughfares, and being conveniently located for passengers, it drew traffic from both the elevated railways and the street cars as the public became more and more subway-minded. Surface traffic congestion and lack of maintenance caused further loss of traffic to the street-car systems.

The continuing expansion of the subway rapid-transit railways, culminating with the opening of the city-operated Independent System in September 1932, and the previously mentioned factors, brought about the abandonment of street-car operation in the Borough of Manhattan and the substitution of buses except on routes of the Third Avenue Railway Company. This company has maintained its tracks and rolling stock in good condition and is at present adding to its rail facilities.

Upon the abandonment of most of the surface-car lines in the Borough of Manhattan, these streets were repaved and the new buses replacing the old cars have developed an extensive short-haul and convenience traffic, leaving the long-haul residence-to-business traffic largely in the hands of the rapid-transit lines. Although the buses carry a substantial and increasing traffic, they do not, except in a limited sense, provide transportation. They have relieved traffic congestion only to the extent that they are used in preference to taxis and private cars. In order to make more room for other traffic, the former street-car passengers have been compelled to travel underground—and although they had no choice in the matter they are expected to like it, and to pay the full cost thereof.

Buses with 32 and 40 seats, operating on a 5-cent fare and a 2-cent charge for each transfer, had the following gross revenues per bus mile on the main routes in 1937:

Madison Avenue	.55 cents per bus mile
N.Y.C. Omnibus Corporation	.55 cents per bus mile
Comprehensive Bus Company	.54 cents per bus mile
Eighth Avenue	.53 cents per bus mile
East Side	.38 cents per bus mile

Subways, furnishing practically city-wide transportation, carrying from 150 to 250 passengers per car during the rush hours and with a fair seat load during the rest of the day, currently show the following gross revenue per car mile at a 5-cent fare:

Interborough Rapid Transit	.25 cents per car mile
B.M.T. System, Subway and Elevated	.32 cents per car mile
N.Y.C. Independent System	.26 cents per car mile

These revenues show that rapid-transit subways of the City of New York provide necessary transportation, while buses serve as a convenient substitute for walking. It is obvious that, where distance and volume of traffic are substantial, rail transportation remains the most important element of the urban transit system.

AUTOMOBILES AND PEDESTRIANS

In our review of the various means of city transportation, we come at last to the private passenger automobile—the most mobile, and frequently the fastest, though the most expensive means of all. In most instances the private passenger automobile is bought as a pleasure vehicle and its use for business transportation becomes,

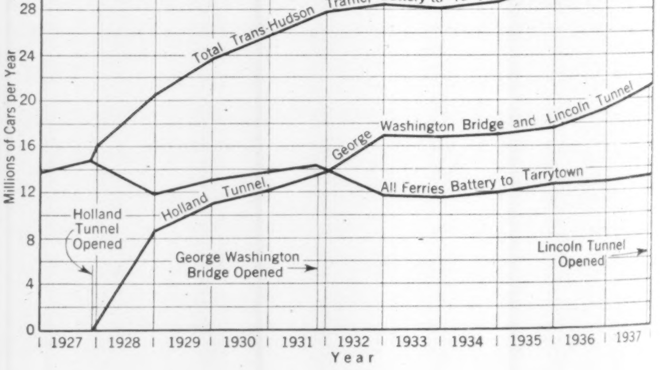


FIG. 2. TRANS-HUDSON VEHICULAR TRAFFIC, 1927–1937
Data from Port of New York Authority

in the cost accounting of the owner, merely an incidental to be figured on a mileage basis for the gasoline and oil used. The disadvantages of the private passenger automobile are physical wear on the rider when he is also the operator, and the ever-present parking problem. The private passenger car occupies more of the limited roadway space of the city streets than its value as a transportation medium warrants. This use of city streets is not even remotely paid for by automobile taxes or license fees, so that from a civic standpoint the private passenger automobile in transportation service often becomes a nuisance and sometimes a menace.

The pedestrian has almost disappeared, although of necessity people still walk to and from one of the transportation media or for other short distances. Traveling on shoe leather from home to work has practically ceased to be a means of transportation for the city dweller.

In every metropolitan area there are thousands of private passenger automobiles available for daily business transportation, but actually restricted to social and recreational use by traffic congestion. Every street or highway improvement intended to relieve congestion brings some of these automobiles into daily service. More than that, the completion of any traffic relief project actually increases the number of automobile owners —for the number of private automobiles within a metropolitan area is not limited by purchasing power but by the available highway and roadway space in the business center of the city. In attempting to provide adequate facilities for traffic, cities are in reality creating facilities for more traffic.

©Harris and Ewing

Market Street, the Main Business Thoroughfare of San Francisco, Has Four Lanes of Street-Car Tracks

IMPROVED FACILITIES CREATE MORE TRAFFIC

This is aptly illustrated by the trans Hudson River traffic between New York City and New Jersey (Fig. 2). One of the reasons for building the Holland Vehicular Tunnel from lower Manhattan to Jersey City was to release waterfront property used by ferries for commercial shipping. Since its completion the George Washington Bridge and one tube of the Lincoln Tunnel have been opened to traffic, but the ferries are still doing almost as much business as in 1927. The traffic created by the changes in riding habit and by the increase in the auto-truck delivery business, due in a large measure to the availability of these trans-river traffic facilities, has compelled the State of New Jersey and the City of New York to expand the highway and street facilities leading to these river crossings. Thus relief for congestion creates more congestion, calling for more relief ad infinitum. A possible balance may be obtained by retaining useful existing transportation agencies in service and by gaging the relative social and economic values of the new transportation services so that facilities will be provided, not in accordance with demand, but in proportion to civic need and financial resources. The best that can be hoped for is to make everyone equally uncomfortable.

Transit Journal

Traffic Congestion in the Heart of St. Louis, Mo.

In many cities, traffic from main arterial highways aggravates the transit and traffic problem. Non-stop through traffic should be provided with facilities that would induce it to keep off the city streets. By-pass freeways are a partial remedy, as they will keep some of the through vehicular traffic out of congested sections; elevated or depressed highways within the city, where conditions are favorable for their construction, will accomplish the same result. That part of the highway traffic, and of the local vehicular traffic, which has the community center for its destination cannot be diverted and must have mobility if the city is to function efficiently.

Traffic lights, parking ordinances, roadway widenings, one-way streets, isolated grade separations, and other palliatives reduce the traffic congestion in city streets, but they do not remedy it. These improvements in facilities for surface traffic to ease congestion invariably attract proportionately more traffic, resulting in still greater congestion in the city streets. The widening of roadways by reducing sidewalk widths is not sound

HEAVY TRAFFIC ON THE STREETS OF THE NATION'S CAPITAL

long-range practice as it merely shifts the congestion from the vehicular area to the pedestrian area of the street.

Additional roadway space can be obtained by cutting new streets through the built-up sections of the city or by widening existing streets. Both methods are expensive and result in the destruction of property from which the city obtains part of its tax revenue. In some cases these methods may even adversely affect the character of a neighborhood.

AN ALTERNATIVE TO STREET-WIDENING

The alternative to widening streets horizontally is to permanently separate the different kinds of surface traffic by introducing a new traffic level within the existing street width. Elevated structures or subways for rail operation would remove urban mass transportation from the street surface. Doing so in effect widens the street by at least two traffic lanes, or 22 ft. The destruction of property is avoided, mass transportation can function, and the remaining surface traffic will move at a faster pace, saving time and energy for all.

Elevated railways are comparatively low in first cost and many riders may prefer them to subways as a transportation medium. From a civic standpoint, however, they have many disadvantages, chief of which are obstruction of the streets by columns and stairs, and interference with light, air, and access to abutting property, making such property less desirable and less valuable for business or residential purposes. In New York City, the elevated railways were the principal means of long-haul rapid transit prior to 1904, but because of their objectionable features they were not permitted to occupy the main traffic streets. This naturally limited their business to rush-hour and long-haul necessity transportation. Street cars on the main thoroughfares took care of intermediate and short-haul traffic and of most of the casual riding.

Subways are much more expensive than elevated railway structures, but they do not have the undesirable features of the latter. On the contrary, subways enhance the value of abutting and surrounding property by increasing the total traffic capacity of the street and by eliminating the noise inherent in any form of surface transportation. Moreover, they can provide more convenient close-to-destination service for passengers, as they can be built under high-class business and residential streets which would be barred to elevated railways or elevated highways.

Very few cities have enough local traffic for a transportation system composed entirely, or even in part, of subways that would be self-supporting at a reasonable rate of fare. Only a few cities have built subways, because in the popular mind they are associated with long-distance rapid transit. Nevertheless, many cities need simple transit subways.

THE DUAL FUNCTION OF THE SUBWAY

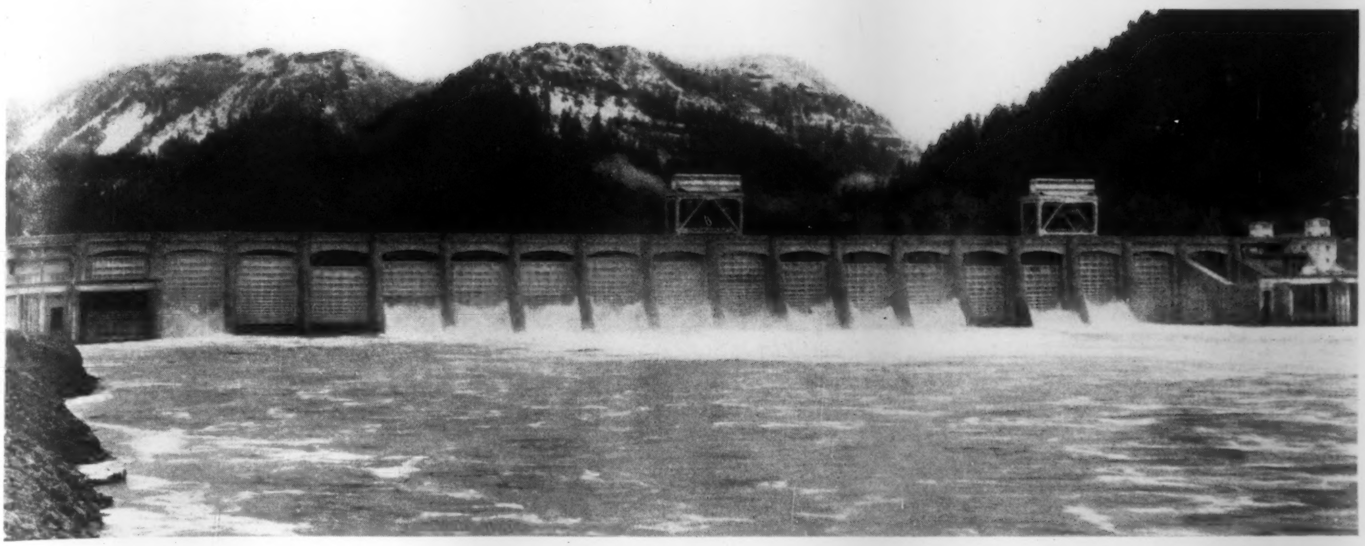
Subways are generally considered to be solely transportation media, whereas in addition to that service they also produce, in effect, a street widening. It follows logically that they should be thought of as an integral part of the street system, even though they are set aside for the exclusive use of rail transportation facilities. This concept alters materially the possible method of financing such a project. For, considering a subway partly as a railway and partly as a street improvement, its cost may reasonably be divided among the several groups of beneficiaries upon the following basis:

1. The passenger should be required to pay for the transportation provided.
2. The abutting and surrounding property should contribute the equivalent of the cost of street widening.
3. Property in the territory served directly and indirectly by the transportation lines using the subway should contribute in proportion to the increase in land value resulting from better transportation facilities.
4. The community as a whole should contribute, as there will be greater tax returns due to the stabilization of real estate values in the community center and increased land values in the residential sections.

The interrelated problems of urban passenger transportation and of traffic congestion will be solved when officials and civic bodies cooperate with the engineers in educating the citizen to the realization that no single group of beneficiaries can be expected to assume the entire cost of such a joint undertaking. The equitable division of cost between the several groups of beneficiaries is a complex problem. That there are several groups of beneficiaries has been recognized in the proposals for financing the construction of passenger transportation subways for Detroit and Chicago. A study of the detailed provisions of these plans reveals variations showing that the financial problem must be worked out to suit the conditions in each community.

Political boundaries, financial resources, statutory limitations, climatic and topographic conditions, intensity of land utilization by high buildings, existing transit and traffic facilities, and the riding habits of the people, all of which vary from place to place, are important factors in creating the transit and traffic problem. These factors must be evaluated and the general trend forecast in order to arrive at a satisfactory permanent solution that is economically justified.

Cities of 500,000 or more population that lack rapid-transit facilities will have to build rapid-transit subways owing to the combination of the long distance to be traveled from home to work and the traffic congestion in the community centers. Cities in the 100,000 to 500,000 group face a difficult problem in that there is a temptation to resort to temporary expedients or to provide relief at isolated points of maximum traffic congestion. Over a period of years, the total expenditures for such stop-gap programs would, without achieving any satisfactory permanent results, probably be as much as the ultimate cost of the progressive execution of a coordinated plan. For these cities, part of the logical solution of the transit and traffic problem is to build transit subways through the community center for local rail-passenger transportation vehicles, such subways to be planned and built so that, when necessary, they can be readily adapted to rapid-transit service.



THE SPILLWAY SECTION OF BONNEVILLE DAM

"Third-Step" Construction at Bonneville Dam

Unique Cofferdam Structures Required for Completion of Spillway Section

By B. E. TORPEN, M. AM. SOC. C.E., *and* O. C. HARTMAN, ASSOC. M. AM. SOC. C.E.

RESPECTIVELY SENIOR ENGINEER, BONNEVILLE PROJECT, AND ENGINEER, BONNEVILLE DAM, BONNEVILLE, ORE.

THE third and final step in the construction of Bonneville Dam—the completion of the ogee section in six bays of the main spillway structure—is recounted here. Of special interest is the description of the unusual cofferdams, or bulkheads, that were used to unwater each of the bays in turn.

Articles on the earlier stages of construction at Bonneville and on the model studies that guided the design appeared in "Civil Engineering" in October 1936.

THE Bonneville project (Fig. 1) comprises a ten-unit power house, a ship lock, a spillway dam 1,300 ft in length, and two connecting levees. It was constructed in three steps. The first included the unwatering of the south half of the river and the erection of all structures including and south of Pier 9, with the exception of the upper part of the spillway sections in the bays between Piers 11 and 18. The second step consisted of unwatering the north half of the river and erecting all structures north of Pier 9. During this operation the flow was passed through the bays that had been left unfinished in Step 1. The third step was for the purpose of unwatering, individually, Bays 11 to 17 and constructing the upper portion of the ogee sections therein. The present article is limited to a duscussion of the third-step operation.

A section through a typical bay, showing the third-step cofferdams in place, is presented in Fig. 2. The piers are 10 ft in thickness, and are spaced 60 ft center to center.

The original contract drawings had provided for cofferdams like those of Fig. 3. The downstream structure was to be a timber crib, constructed between adjoining piers. Upstream, precast concrete slabs, reaching from pier to pier and surmounted by a timber crib, were to provide the closure. The slabs were to be supported by a central pier and were to become an integral part of the completed spillway section. Model studies, made after the letting of the contract, indicated a number of undesirable features in this design, and were responsible for the later change in plans.

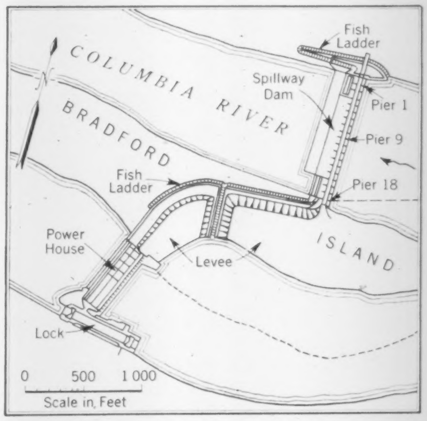


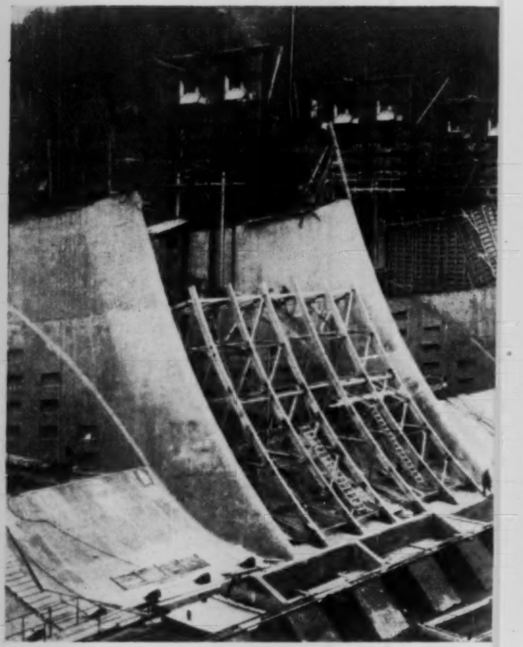
FIG. 1. GENERAL FEATURES OF BONNEVILLE PROJECT

DESCRIPTION OF THE COFFERDAMS

As shown in the accompanying photographs, the downstream cofferdam finally adopted consisted of timber pads, supported by six light trusses which rested on the completed portion of the ogee sections. The trusses were pinned to trunnion castings anchored into the concrete, and their outside faces were in line with the noses of the piers. The pads, of 8-in. timbers, were built up in sections and placed with the main cableways (the "Hi-lines"). They extended 2 ft beyond the center line of the pier noses, and were trussed with reinforced concrete ribs. Rubber strips on the pads where they rested on the pier noses, and 3-in. rubber hose attached to the edges of the pads where they rested against each other and the concrete deck, made the water seal. This design proved highly satisfactory.

The upstream cofferdam consisted of steel needles, made of 30-in. I-beams, with interlocks cut from Z-type steel sheet piles. A typical needle is shown in section in Fig. 4, together with one of the steel columns constructed to fit over the noses of the piers. There were 15 needles of the type shown, and one, designed to be used as a closure pile, in which the interlocks were bolted to the base through slotted holes, to permit of lateral adjustment during placing.

The box columns at the noses of the piers were constructed with side plates extending far enough down-



TRYING OUT THE DOWNSTREAM STEEL TRUSSES "IN THE DRY" TO SET THE CASTINGS PROPERLY

DIVERS GO DOWN WITH THE TRUSSES TO GUIDE THE PINS INTO THE TRUNNIONS, 30 FT BELOW THE SURFACE

stream to enclose laminated wood strips cut to fit snugly around the pier nose. Until the cofferdam was unwatered, the columns were held in place by cables attached to the gates above the pool level.

A seal beam, made up of a 10-in. H-beam faced with wood, served as a spreader between the bottoms of the columns and also as a filler between the bottoms of the needles and the vertical face of the step at El. -10.

To prevent uplift of this beam, a latch that could be pulled out over its end plates was provided in the bottom of each column.

The top of the needles was supported by a horizontal steel truss (Fig. 2) acting against the pier noses. The upstream chord of the truss was supported by the steel columns, and the downstream chord was attached to brackets anchor-bolted to the side of the piers.

To make this cofferdam tight, 3-in. rubber hose, to be inflated with air, was inserted in the laminated wood strips of the columns on each side of the center line, and also in the wood face of the seal beam contacting the bottom of the needles and the concrete of the -10 step. One-inch sheet rubber provided a seal between the end plates of the H-beam and the columns.

SEASONAL OPERATION DURING CONSTRUCTION

During the first-step construction period and before the water was admitted to the first-step cofferdam, the trunnion castings and base plates to support the third-step downstream cofferdam trusses were placed. It was necessary that the castings and plates be set accurately in order to assure a uniform bearing of the timber pads on the pier noses and the six supporting trusses. The anchor bolts having been placed, the trunnion castings were set with an instrument and grouted. As the bearings on the trusses that rest on the upper base plates were slightly out of normal, the trusses were blocked in place and alined with the downstream pier noses by means of a tightly stretched piano wire, and the plates were grouted to the truss bearings. This necessitated setting the trusses in each bay in turn until all the plates were grouted in.

The actual work on unwatering the third step started in December 1936. Before placing the cofferdams, of course, it was necessary to close off the flow of water in the bay in which they were to be installed. It was intended that the spillway dam gates would be lowered for that purpose, but as none were ready for use at that time the contractor made up two gates of concrete and wood stop-logs that had been used in the temporary fishways. Working under the handicap of freezing weather, but aided greatly by an all-time low flow in the river, the third-step work in Bays 16 and 17 was completed on February 16, 1937. The head between the upstream pool and tailwater during this period did not exceed 9.5 ft, which also was a decided advantage.

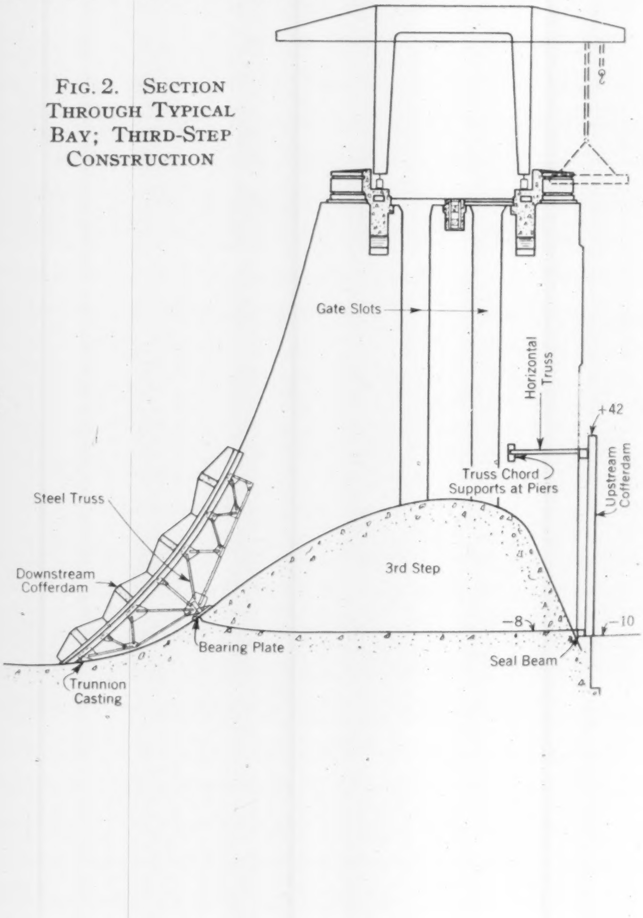


FIG. 2. SECTION THROUGH TYPICAL BAY; THIRD-STEP CONSTRUCTION

Nothing further was done until after high water. Work on the five remaining bays was started on August 7, 1937, and completed on November 1. During this period the river flow held slightly above normal, varying between 177,000 and 74,000 cu ft per sec. The head fluctuated between 16.8 and 24.5 ft. This volume of water and increased head added considerably to the difficulties of the work.

SEQUENCE OF OPERATIONS

The major items of equipment provided by the contractor for the construction of the dam were two cableways of 25-ton capacity equipped with traveling head-towers, both operating from a single fixed tail-tower. For the third-step operation the cableways were ideal, and all the units of the upstream and downstream cofferdams were placed and removed by them. The contractor also provided two large hoist barges, one upstream and one downstream of the dam, and two small divers' floats equipped with air pumps. The hoist barges were used in conjunction with the cableways in setting the cofferdams, and divers worked from the floats in placing or guiding the under-water members.

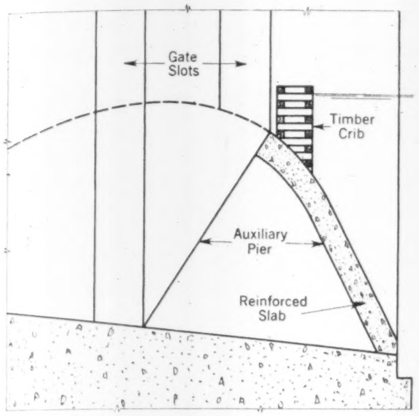
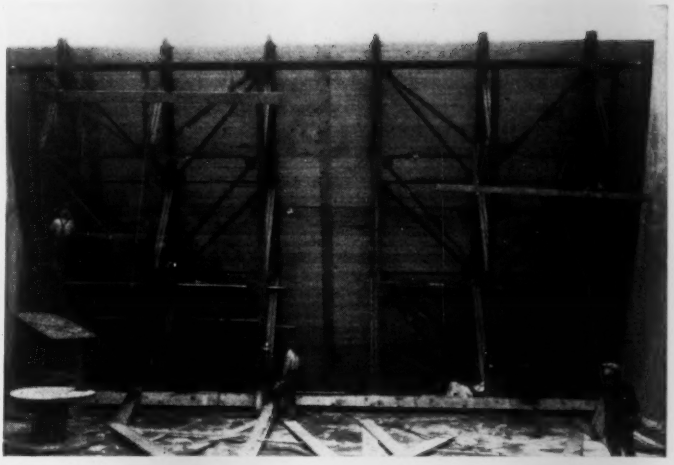


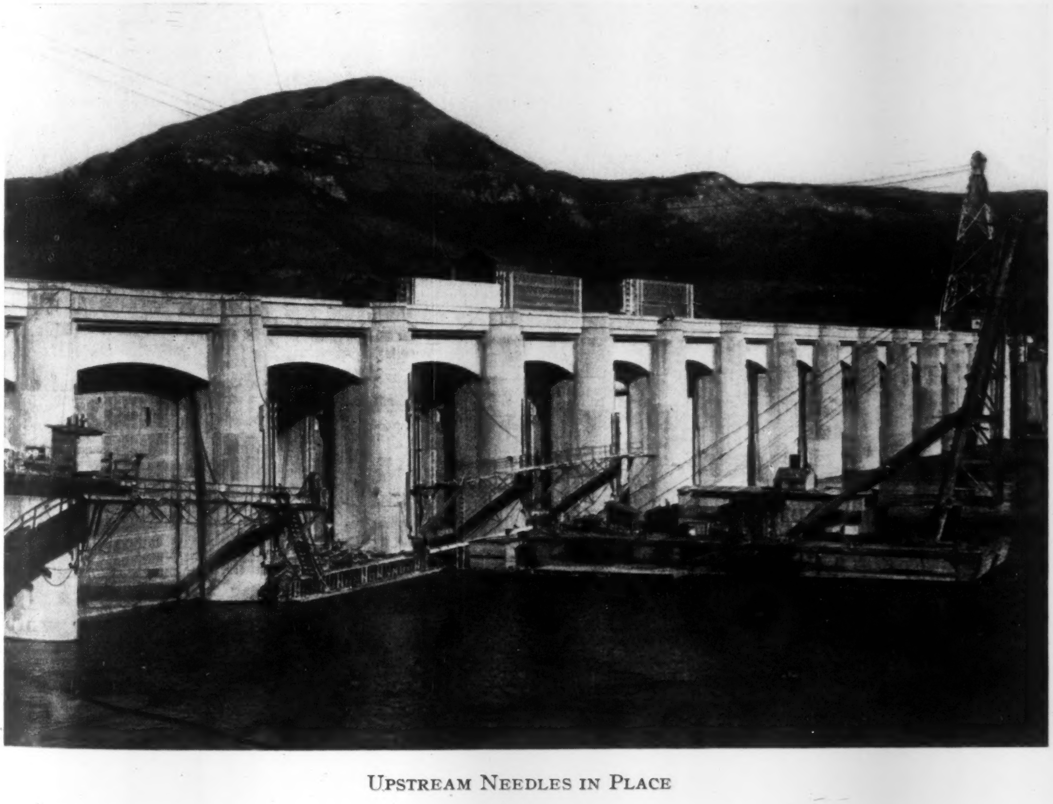
Fig. 3. Original Design for Third-Step Cofferdams



An "Inside" View of the Downstream Cofferdam

By August 1937 the spillway gates were in place and could be lowered to still the water upstream and downstream of the bay to be cofferdammed. Because of the high flow, and the hazards from strong cross currents, it proved necessary to close off not only the bay in which work was to be done, but at least two on each side in addition. The gates were raised, lowered, and shifted with the 350-ton gantry crane operating on top of the dam.

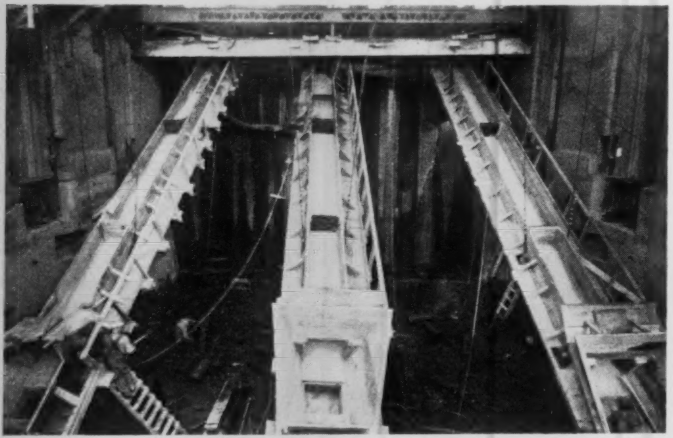
When sufficient gates had been lowered and sealed reasonably tight, so as to permit a diver to work without too much hazard, a very thorough investigation was made, both upstream and downstream of the area to be occupied by the cofferdams. If deposit was found, it was at once removed, and the cableways then proceeded with the placing of the downstream trusses. These were lowered in place in groups of three; the connections were guided into the trunnion castings and pinned by divers; structural angles connecting the two groups were bolted; and jack arms on the outside trusses were set against the inside of the pier noses. Following this—or at the same time, if two cableways were available—the nose columns of the upstream cofferdam were placed and fastened. Next the upstream seal beam was set and latched, and then the divers placed against it, on the sill, a combination oakum and canvas pad 6 in. in diameter. This pad formed an excellent seal between the concrete and the bottom of the needles, which were set upon it, and practically eliminated the necessity for the inflated rubber hose provided in the upstream face of the seal beam.



Upstream Needles in Place

HOW "BOLONEY" IS MADE

When the needles were in place, the divers immediately tightened the slotted interlock bolts and proceeded to calk all leaks. In general this was done with soft pads, patterned after the one placed beneath the needles on the -10 step. A description of these pads, locally known as "baloney," is worthy of mention as they were particularly successful in sealing all openings of any size. They were made by wrapping oakum around a tightly stretched $^3/_4$-in. manila rope, and in turn covering the oakum with a second wrapping of canvas and an outer wrapping of $^3/_8$-in. manila rope. The length and diameter of the "baloney" was varied to fit the size of the opening as reported by the diver, and sizes up to 60 ft long by 18 in. in diameter were used. All small leaks were sealed with cinders.



CHUTES FOR DELIVERING CONCRETE
In the Background Are the Upstream Needles, Holding Back 34 Ft of Headwater

As soon as the upstream closure was made, the pumping was started with one 200-hp pump and one 50-hp pump. By the time the sealing was completed the smaller pump, working a very small part of the time, could take care of all the leakage upstream. In the last five bays the divers became so proficient in locating and stopping leaks that after the pump-down and sealing operations were completed, the total leakage amounted to very little over 1 cu ft per sec.

Clean-up of the concrete with compressed air and water started as soon as the bottom was exposed. The copper seals that had been embedded in keyways just inside of the outside perimeter of the spillway section were invariably found to have been damaged by the water diversion, and had to be repaired. Grout boxes and pipes had to be placed, forms built upstream, and screed rods set downstream. The period from the pump-down until the first concrete pour started was from two to three days.

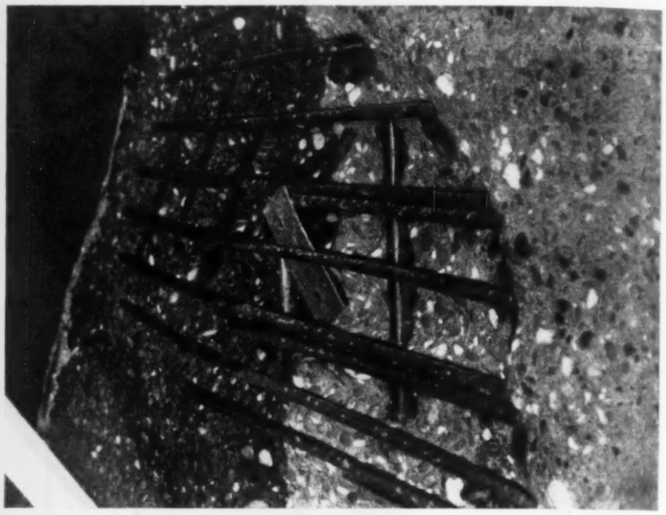
A decided scour was found on the lower part of the downstream noses of all the piers and on the completed part of the ogee sections. It had probably been caused by strong eddies over the sill, and by fill material from the first-stage cofferdam, carried through the spillway by the high water. The scoured areas were carefully cleaned and gunited after the first pour was made.

The concrete in the first three bays was placed with an 8-cu yd bucket lowered between the deck girders by the Hi-line. On account of the very slight overhead clearance, this method was found to be slow and dangerous, and the remaining bays were poured through three chutes made of double 24-in. I-beams suspended from the deck of the dam and sloping upstream. Hoppers were provided on the downstream ends, and gates in the bottom fed into "elephant-trunk" chutes spaced at regular intervals. The hopper was so located that the Hi-line was able to swing in to dump from downstream without crossing the dam, which expedited the operation considerably.

The concrete was placed in four pours, the outside 2 ft of the first three pours and all of the last pour using high early strength cement. The time interval between pours was 72 hours.

ORGANIZATION

Bonneville Dam was constructed by the Corps of Engineers, U. S. Army. Col. T. M. Robbins, M. Am. Soc. C.E., is Division Engineer, Portland, Ore.; Maj. T. D. Weaver is District Engineer; and Capt. C. M. Myers is Executive Officer of the Bonneville District. The Columbia Construction Company were the general contractors, with Edgar Kaiser, Assoc. M. Am. Soc. C.E., as general manager, Clay Bedford as general superintendent, and Harry Davis as assistant superintendent. Jack Harper was directly in charge of the third-step work for the contractors.



THE PIERS WERE SUBJECTED TO CONSIDERABLE SCOUR DURING THE SECOND-STEP DIVERSION
This Was the Worst Spot. During the Third-Step Construction, Such Damage Was Quickly Repaired by Guniting

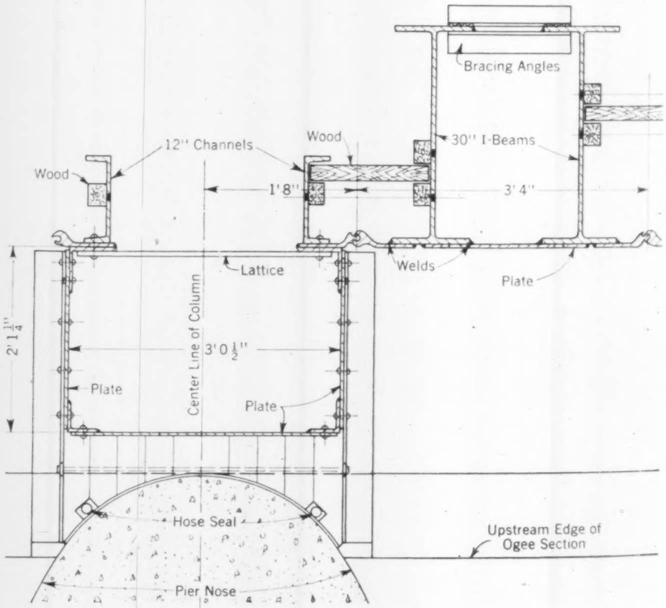


FIG. 4. NEEDLE AND COLUMN OF UPSTREAM COFFERDAM

Bituminous Macadam Road-Building in Oregon

Practice in Other States Studied in Developing Present Methods; Careful Attention to Foundations Pays Dividends

By R. H. BALDOCK
CHIEF ENGINEER, OREGON STATE HIGHWAY COMMISSION, SALEM, ORE.

PERIODICALLY engineers search for the will-o'-the-wisp known as "low-cost roads." Fifteen years ago the Oregon engineers assiduously endeavored to find the answer to that problem and their attempts resulted in a revival of cheap bituminous treatments, which later spread throughout the West. Gradually the character of the construction evolved into a more permanent type. Mr. Baldock here describes the last step in that development—Oregon's present method of building bituminous macadam. He prefaces his description with a number of comments on the three prerequisites for success of flexible surfacings in general. This paper was on the program of the Eleventh National Asphalt Comference, in Memphis, Tenn., December 1937.

ROADS low in first cost are not necessarily low in total annual expense. We cannot ignore high maintenance charges due to inadequate facilities. Neither can the cost of motor operation by reason of poor highway maintenance be disregarded. After all, the economical operation of a motor transportation system is the objective of the highway engineer, and all factors relating to the design, construction, and maintenance of highways must be carefully considered in the light of this major objective.

This does not mean that all roads of low first cost should be barred from consideration. Every improvement should be considered in the light of local conditions—climate, subsoil, available materials and traffic, and the selection of a type based on the estimated lowest annual charge. Light bituminous treatments play no small part in the economic betterment of the transportation system. However, there is a tendency, dictated by expediency, to push the use of such types too far under circumstances which must ultimately spell failure.

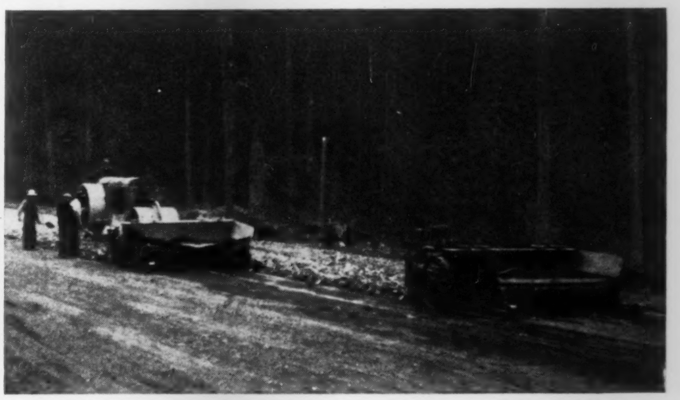
Investigations made by the Oregon engineers proved to their satisfaction that low-cost surfacings can be successful only when certain conditions are met: (1) The roadbed must be well drained; (2) the foundations must be adequate to support the loads which the surfacing is to carry; and (3) if a bituminous surface is to be employed as a wearing course, it must have a properly graded aggregate, uniformly coated with the correct amount of bituminous binder. Let us examine these in turn.

1. Much has been said about drainage. Each road presents its own problem. The means to be employed range from simple surface ditches to elaborate under-drains and drainage tunnels. Suffice it to say that each problem must be correctly solved if success is to be attained. Foundations are constructed to spread the load upon the properly drained subgrade. Of late many attempts have been made to accomplish this result by means of subsoil treatments, employing in some cases various salts, and in other cases portland cement or emulsified asphalt. The results have been rather indifferent while the cost seems quite high. Some success has been gained through the wasting of objectionable soils and the substitution of more suitable material. The use of dynamite in removing peat soils and unstable silt is gaining more recognition each year, while the compaction of soils in thin layers at optimum moisture content through the use of heavy machinery is becoming a universal practice. When gravel or broken stone is economically available, the building of strong foundations through the use of such material is a favorite method.

MR. TELFORD VERSUS MR. McADAM

2. A century ago two famous English engineers, Mr. Telford and Mr. McAdam, had divergent theories with relation to the building of stone roads. Telford claimed that the wearing surface should be placed upon a foundation composed of large stone and of adequate thickness to distribute the load upon a properly drained subgrade.

A "ROMAN ROAD" IN OREGON; NOTE SIZE OF STONE GOING INTO THE BALLAST COURSE



PLACING BASE COURSE OF 4 1/2 TO 2 1/2-IN. STONE ON A WESTERN OREGON HIGHWAY

On the contrary, McAdam contended that 10 in. of small stone furnished ample support on any soil. Opinion with regard to these divergent theories seemed fairly evenly divided among road builders until the appearance of the automobile. As the speed of this new machine increased, the necessity of having fine stone roads became more apparent. The steel tires of the earlier horse-drawn vehicles tended to grind off dust from the larger stone, furnishing a binder, whereas the fast-moving pneumatic tires sucked away the binder; therefore roads built of large stone soon became rough. In consequence, the ideas of McAdam have prevailed for the last forty years and the term "macadam surfacing" has become synonymous with the term "crushed-rock surfacing." However, McAdam's method was based upon the fallacy of building thin surfaces on yielding subgrades, which practice, in all probability, is responsible for much of the heavy maintenance cost of this type of surfacing today.

ROLLING THE FIRST LIFT OF BITUMINOUS MACADAM

Opposed in basic theory to the McAdam type of road are the roads built by the Romans twenty-three centuries ago. Those roads were of a thickness ranging from 2 to 4 ft, of large stones cemented with lime mortar. This was covered by an intermediate course of smaller stones similarly bound, and a wearing surface of flat, polygonal stones with carefully mortised joints set in lime mortar. Some of these roads are in use today after having served for more than two thousand years. While it is true that they have not been subjected to the heavy loads of modern trucking, they have for centuries carried heavy loads in horse- and ox-drawn vehicles on narrow tires and have withstood the destructive action of the elements.

CAREFUL GRADING AND PROPORTIONING NECESSARY

3. Few will contradict the statement that bituminous surfaces must have a carefully graded aggregate and the correct amount of bituminous binder. Some specifications give a certain control which will insure uniformly good results as far as the surfacing itself is concerned. In other specifications, the control of the gradation of the aggregate and percentage of asphalt cannot be definite, and there is a corresponding lack of uniformity in the results obtained. Plant mixes of both open and closed type, having at least a four-bin segregation of aggregate, are based upon specifications giving adequate control by weight of the various ingredients comprising the mixture. Likewise in the building of bituminous macadam it is possible to obtain the specified gradation of the aggregate and percentage of asphalt with a high degree of accuracy.

On the other hand, it is difficult if not impossible to secure any predetermined grading of aggregate, with the corresponding percentage of binder required, by means of the road-mix specification. Similarly, the one-bin and two-bin plant-mix specifications lack control in the fine aggregate, which essentially determines the amount of asphalt binder required.

Inspection of road-mix and cheap plant-mix construction discloses many failures from the use of too high a proportion of asphalt—which causes shoving and displacement of the mixture, often in the form of rhythmic corrugations. This is a contrast to other factors evidenced by cracking and spalling, indicating too low a percentage of asphalt in proportion to aggregate. This lack of control is inherent in the specifications. Occasionally splendid results are obtained, but there can be no certainty.

OREGON BITUMINOUS MACADAM

The present method of building bituminous macadam in Oregon is the outgrowth of a search of the United States for the best technique in macadam construction and a study of the history of road building. It is described in the following paragraphs.

Upon a compacted and drained subgrade there is placed a ballast course of gravel or stone talus ranging in thickness from 12 to 24 in., depending upon the character of the traffic to be sustained and the strength of the subgrade. The ballast is placed over the entire width of the subgrade, from ditch to shoulder line. Wherever possible a sandy gravel is used, and where there is insufficient sand, a sand filler is added. This gives a very permeable base which effectively drains off the water. The subgrade is slightly crowned to prevent the formation of water pockets.

Upon the ballast course is placed a base of chock stone macadam $4^{1}/_{2}$ in. in compacted thickness, and 4 ft wider than the wearing course it is to carry. The size of the stone ranges from $4^{1}/_{2}$ to $2^{1}/_{2}$ in. It is spread with bulldozers and smoothed with motor graders, with such hand spotting as may be required. After it has been rolled, the coarse stone is keyed with $^{3}/_{4}$-in. minus materials. The surface is then protected by a prime coat of from $^{1}/_{3}$ to $^{1}/_{4}$ gal per sq yd of rapid-curing cutback asphalt, which is immediately covered with a small amount of screenings and rolled.

The bituminous macadam wearing surface is then constructed upon the prepared foundation and base. Usually the wearing course is 22 ft in width, and $2^{1}/_{2}$ to $1^{1}/_{4}$-in. stone is spread with mechanical spreaders at a rate of 0.06 cu yd per sq yd. After this has been thoroughly rolled and hand spotted to a true and even contour and grade, bituminous cement is applied at the rate of 1 gal

SHOOTING THE FIRST APPLICATION OF BITUMINOUS CEMENT per sq yd, and this is followed immediately by a spread of 1 $^1/_4$ to $^3/_4$-in. material in the amount of 0.02 cu yd per sq yd. The finer part of the material serves to chink up the interstices of the larger stone, whereas the coarser part serves as a leveling course to take out the small irregularities of the first course. The surface is planed with long-wheelbase motor graders, after which it is rolled and a second application of bituminous cement is applied at the rate of $^3/_8$ gal per sq yd. The asphaltic cement is covered with $^3/_4$ to $^1/_2$-in. aggregate at the rate of 0.009 cu yd per sq yd and $^1/_2$ to $^1/_4$-in. aggregate at the rate of 0.003 cu yd per sq yd.

The first seal coat is then applied. This seal calls for a $^3/_8$-gal application of bituminous cement followed by a spread of 0.006 cu yd per sq yd of $^1/_2$ to $^1/_4$-in. aggregate and 0.003 cu yd per sq yd of $^1/_4$-in. minus aggregate. The material is broomed and rolled until thoroughly compacted. Traffic is then allowed to use the road for a period of four to five days, after which the second seal, consisting of $^1/_4$ gal of bituminous cement followed by a spread of 0.006 cu yd per sq yd of $^1/_2$ to $^1/_4$-in. aggregate and 0.004 cu yd per sq yd of $^1/_4$-in. minus material, is applied.

The asphaltic cement is a 120–150 penetration asphalt heated to a temperature of 425 F, the same grade being used in all applications with the exception of the second seal coat. A water-soap solution is sprayed on to the road with the asphaltic cement, through the same openings in the spray nozzles, the quantity of solution used being about 10 per cent, by volume, of the quantity of asphaltic cement. The temporary emulsion thus formed coats the stone thoroughly. The asphaltic cement in the second seal may be either cutback asphalt or emulsified asphalt. Each square yard of the bituminous macadam wearing surface requires 2 gal of bituminous cement, including the cutback or emulsion, and 0.111 cu yd of aggregate. Each course of the pavement is thoroughly rolled with 10-ton, 3-wheeled rollers, until the stones are mechanically locked.

The surface texture of this type of pavement is somewhat coarser than a sandpaper finish, the $^1/_2$-in. stone and the $^1/_4$-in. stone being evident. The voids in the base stone act as a reservoir to absorb excess asphalt in hot weather, with the result that this type of pavement seldom bleeds and remains remarkably uniform in texture throughout the years. Oregon's experience extends over a period of about ten years.

SKID RESISTANCE AND ELIMINATION OF GLARE

One of the main objectives in the building of pavements is the creation of a surface that has skid-resistant properties and that minimizes the reflection of "glare" of headlights. Professor R. A. Moyer, M. Am. Soc. C.E., of Iowa State College, found that the coefficient of friction for wet bituminous surfaces covers a wide range. His determinations indicated quite clearly that the coefficients for high-type non-skid asphaltic-concrete and bituminous-macadam surfaces are consistently higher, under wet conditions, than those for other types of surface. He found, also, that unusually low coefficients of friction are obtained on bituminous surfaces when they are covered by a skin of free asphalt, and that the coefficients increase with an increase in the hardness of the asphalt or tar binder.

Spreading 1 $^1/_4$ to $^3/_4$-In. Material

The Finished Product—A View on U. S. 99, in the Siskiyou Mountains of Southern Oregon

Experiments carried on by the Oregon State Highway Department indicate quite clearly that smooth-textured pavements reflect more light than rough-textured ones. The reflective glare from wet surfaces is in the main a function of the texture, and the least glare is given by surfaces that are so deeply indented or grooved that water is not held by surface tension but drains off with sufficient rapidity to prevent the formation of a water film, which acts as a mirror. Such a film has the double effect of decreasing skid resistance and causing objectionable glare in night driving. The texture of the Oregon type of bituminous macadam is such that it meets the requirements of both resistance to skidding and elimination of glare.

These Oregon roads are built almost entirely by machines with the minimum of hand labor. They compare favorably in smoothness of riding surface and non-skid properties with similar pavements laid elsewhere. The cost range is wide owing to varying availability of materials, varying character of subgrade, and varying amounts and character of traffic. Under most favorable conditions, the cost, including foundation and base courses but not including grading, totals about $10,000 per mile. Under extremely unfavorable conditions, it will run as high as $20,000 per mile. Such roads carry a traffic ranging from 500 to 2,000 motor vehicles per day. The average cost of maintenance over the past three years has been $150 per mile annually.

Bituminous macadam pavements constructed on well-drained subgrades and with adequate foundations, have demonstrated their ability to successfully withstand heavy traffic and to render a service quite comparable with that of the higher types of pavement. Like other flexible types of surfacing however, the wearing surface itself has no very considerable spanning strength. Strong and durable foundations are therefore essential.

Beauty in Short-Span Highway Bridges

Practice of Designing Each Structure Individually Dates from Beginning of Present Century

By Leslie R. Schureman
Associate Member American Society of Civil Engineers
Assistant Professor of Civil Engineering, Princeton University, Princeton, N.J.

A NUMBER of articles have appeared in the technical press on the history and development of bridge architecture as it relates to structures of large size. Among these, for example, was Wilbur J. Watson's paper in the March issue. On the other hand, very little has been written on the comparatively recent development of short-span highway bridges in this country. These bridges also present problems in architectural design, says Professor Schureman, and the men responsible for their present degree of perfection deserve recognition for a most excellent job of pioneering.

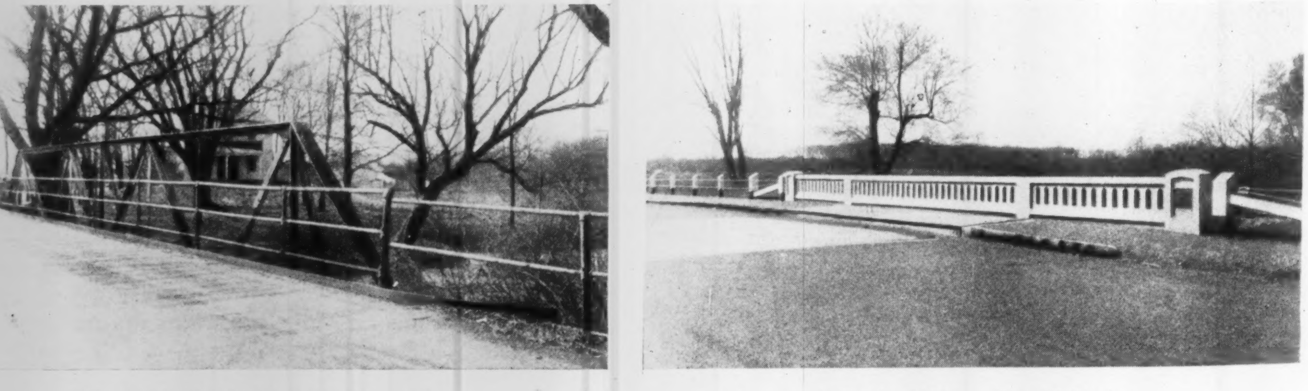
IT should be emphasized that the small bridge differs greatly from the large bridge in the matter of esthetic design. The large bridge is viewed in its entirety only from a distance. At close range, one sees but a part of the structure, more or less unrelated to the whole. It achieves beauty through its grandeur or boldness, or through the intrinsic beauty of long sweeping lines. The small bridge, on the other hand, is seen in its entirety at close range and must achieve beauty not only through proper proportion, but also through a pleasing treatment of line and surface, and a style in accord with its surroundings. The design of the small bridge is further governed by the requirements of line and grade of the supported highway, by the hydraulic requirements of the waterway or the width and grade of the underpassing highway, and by the funds available. It is obviously no small task to produce an esthetically satisfactory result under these conditions. The very fact that it is being done every day bespeaks the proficiency which designers of the "garden variety" of highway bridge have attained.

TWENTIETH CENTURY BROUGHT IN NEW PRACTICES

The evolution of the modern highway bridge has been gradual but continuous since the days when a bridge design was selected from a file of standard plans with no regard for its fitness to the location. Today there are countless well-conceived and esthetically sound structures, each individually designed to conform to its surroundings. The beginning of this evolution dates back to the early years of the twentieth century. At that time the automobile was still an object of curiosity; the organization of state highway departments had just begun; and hard-surfaced roads, except in the cities and larger towns, were a rarity. The short-span highway bridges of that time, barring the relatively few stone masonry arches, consisted principally of iron, steel, and timber trusses, the latter usually covered for protection from the weather. Those of iron and steel, designed in many cases by competing structural steel companies, were patterned after standard railroad designs of the day. These structures achieved popularity chiefly through their low cost and ease of erection. They were designed primarily for utility and were definitely not pleasing in appearance. Some bridges of this type are still in use today, but they symbolize a past era in the history of highway bridge design.

As the motor vehicle gained in popularity, the state highway departments were forced into intensive development and expansion. The urgent need for many bridges of relatively short span led to the establishment of bridge divisions in these departments, and thus the "highway bridge engineer" was born. His job was to produce enduring structures that would safely carry the traffic of the day at the least possible cost. His materials were stone, steel, timber, and concrete. It was natural for him to pattern his first designs after the low-cost, strictly utilitarian truss structures then so prevalent.

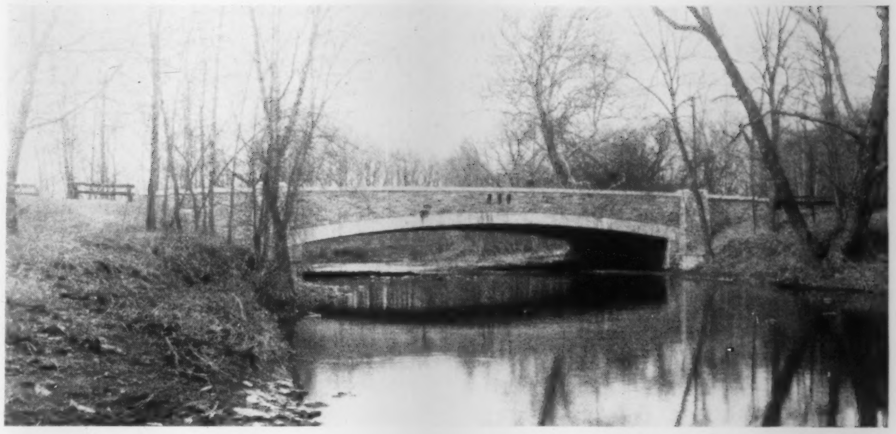
It soon became apparent, however, that the appearance of the bridge was largely the basis on which it was judged by the public, a phenomenon whose import grew as traffic volume increased. This factor fostered a natural desire on the part of the highway bridge engineer to improve the appearance of his product. There had always been beautiful stone arch bridges, but stone masonry was expensive, and in addition there were many locations where the arch could not be used. Consequently the designer was faced with the apparently impossible task of producing a structure of pleasing appearance from steel, timber, or concrete. At that time there were no such structures in this country and no historic precedent to serve as a guide in their design. Architectural texts yielded little practical data that could be applied to the relatively



The Esthetically Obsolete Truss Type

A Typical "Open-Road" Design

A Motorist's-Eye View of Two Short-Span Highway Bridges



This Stone-Faced Bridge of Reinforced Concrete Lends Itself Well to Its Scenic Surroundings

Rigid-Frame Structure of 70-Ft Span near Princeton, N.J.

short-span highway bridge. Forced to pioneer, the designer turned to experiment, guided only by his sense of proportion and fitness, and still restricted by the sine qua non of economy.

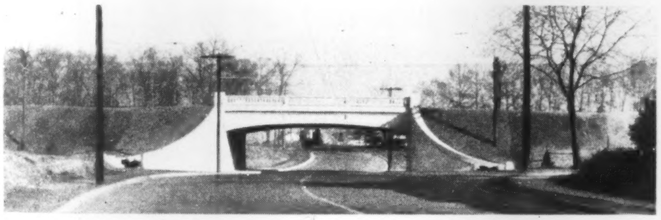
The work done in these early years of experimental design and construction disclosed certain fundamental facts which have been substantiated in subsequent work. For the shorter spans, steel, although inexpensive, proved a relatively harsh, inflexible medium, which did not lend itself well to esthetic treatment. Timber, previously used only for temporary construction, was found to be most appropriate for rustic settings. Reinforced concrete, because of its susceptibility to almost any treatment and also because of its low cost, came to be generally adopted as the ideal material for the shorter spans, except where the character of the site or other considerations called for stone masonry or timber. There was, however, an understandable disinclination to use concrete for the longer spans except in arch construction. For bridges of this class, structural and economic considerations dictated the use of steel. Deck construction, with appropriate treatment of the other elements of the structure, helped to produce a pleasing appearance. Many designers chose to use rolled steel beams encased in concrete. The concrete encasement simplified the problem of esthetic treatment and also served to protect the steel from the weather.

EXPERIENCE HAS TAUGHT MANY VALUABLE LESSONS

Considering the experimental nature of the work and the part played in it by the judgment and opinion of a large number of men of varying abilities and temperaments, it is not surprising that the results have not been consistently good. Many mistakes have been, and are still being made. Mistakes in choice of type and material, poor balance in the proportions of the various elements of the structure, and a gross intemperance in the use of ornamentation are common. But much has been learned from these mistakes. It is now realized that, from the esthetic point of view, the choice of type and material must be governed not only by the peculiarities of the site and the degree to which the structure is exposed to view, but also by the character of the neighborhood. The park area, the industrial zone, the residential zone, and the open road each requires a distinctive type of bridge.

Mistakes made in proportioning the elements of the structure have impressed upon the designer the necessity of making exhaustive preliminary studies. Today, many side elevations, perspective views, and even three-dimensional models are used to obtain a proper balance of mass. Increased camber and the use of either U-abutments or false wings to lengthen the balustrade help to prevent an appearance of heaviness and stubbiness. Intemperance in the use of ornamentation is fortunately fast disappearing. Today ornamentation takes the form of a treatment of line and surface designed to avoid monotone through the use of shade and shadow rather than through the extraneous and even incongruous embellishment seen on some of the earlier structures.

With the increased demand for grade-crossing elimination, the esthetic aspect of bridge design has become of broader interest and even greater importance. This added emphasis placed upon esthetic bridge design has given rise to, or at least has hastened, the development of what may be called the "highway bridge architect." In many instances he is an engineer who has acquired facility in the architectural treatment and esthetic design of highway bridges of relatively short span. Less frequently, he is a trained architect who collaborates with the engineer. In smaller organizations, the bridge designer himself, through study and observation, has been able to greatly improve the appearance of his product. The many well-proportioned and truly beautiful highway bridges throughout the country bear witness to the efforts of these men.



Example of Adaptability of Concrete to Esthetic Design

Railway-Highway Grade-Separation Structure of 50-Ft Span in Residential Zone of Trenton, N.J.

DANGER OF RELIANCE ON RULES AND FORMULAS

A disturbing tendency has recently appeared to formulate rules concerning the architectural aspect of bridge design. For the most part, these rules have been derived from broad basic principles that are applicable to all divisions of architecture. In esthetic bridge design, which is so ill adapted to standardization and generalization, it is obviously unwise to place too much reliance on these formulas. The danger lies not in the unquestionably sound principles, but in their interpretation. Experience teaches one thing above all others—that there is no short cut in the esthetic design of a bridge. Formulas, rules, and tables cannot possibly take the place of painstaking study and analysis in the effort to achieve the best possible solution of each individual problem.

Much has been accomplished in the last twenty-five years, but the work has only begun. The future, with its freeways, parkways, express highways, and grade separations promises many new problems and greater opportunities in the field of modern highway bridge design.

Making Highway-Railroad Crossings Safer

With Special Reference to Problems and Practices in the State of Illinois

By A. BENESCH

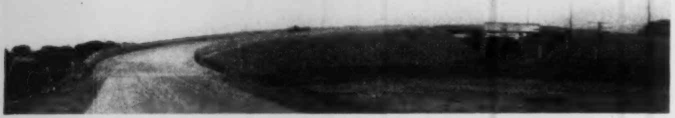
ENGINEER OF GRADE SEPARATIONS, ILLINOIS DIVISION OF HIGHWAYS, SPRINGFIELD, ILL.

POPULAR interest in grade-separation projects may easily detract attention from cheaper means of reducing the hazards of the highway-railroad intersection. However, grade separations can never be provided for more than a very small portion of the country's grade crossings; elsewhere such safety devices as signals and gates must suffice. Mr. Benesch here reviews the possibilities impartially, in a manner that should be of interest to engineer and layman alike. His paper was first presented in March 1938 before the Central Illinois Section.

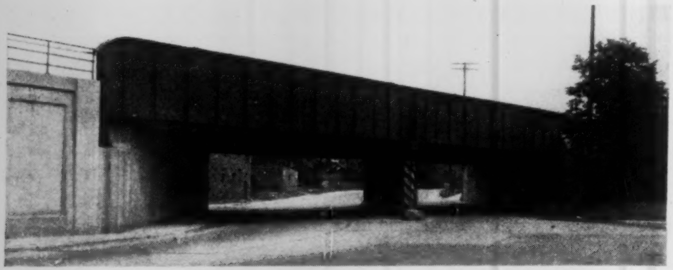
THE problem of the highway-railroad crossing is rightly causing both the railroad engineer and the highway engineer a great deal of worry. In 1936 (the last year for which complete figures are available) there were 4,277 accidents on highway grade crossings throughout the country. Almost 5,000 people were injured, and 1,786 were killed. For Illinois, where there are more grade crossings per mile of railroad than in any other state, the figures were particularly discouraging—396 accidents, 208 fatalities.

How can we solve the problem? Frankly, we can't—completely. But I sincerely believe that there is room for a great amount of improvement which will relieve the existing situation.

The various possibilities may be classified into three major groups, namely (1) grade-crossing elimination, (2) grade-crossing protection, and (3) safety campaigning. Under the first main group, in turn, may be listed (*a*) the closing of an existing crossing that is not used extensively; (*b*) the detouring or relocating of an existing highway; (*c*) the relocating of railroad tracks; and (*d*) grade separations. We need not dwell on items (*a*), (*b*), and (*c*). However, let us look a little into the matter of separating grades.



Poor Alinement, Both Horizontal and Vertical



Sharp Curves, Center Pier, and the Added Hazard of a Little Triangle of Unacquired Right-of-Way

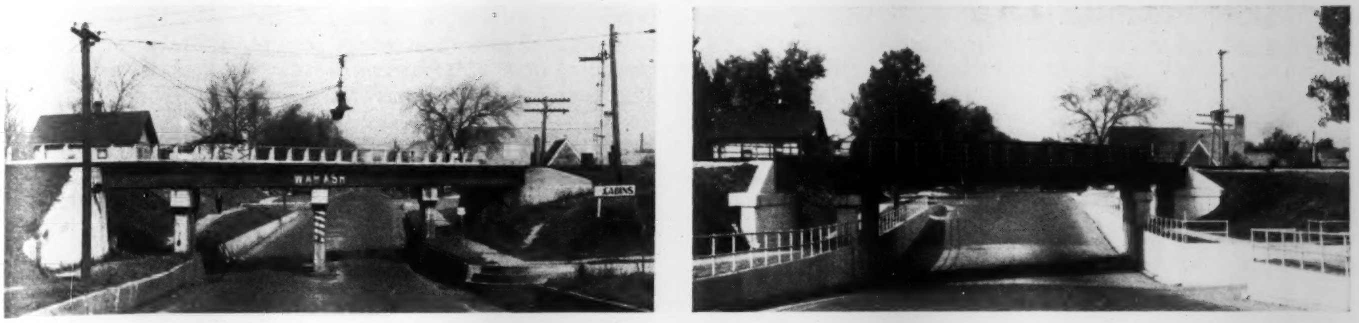
UNSATISFACTORY GRADE SEPARATIONS

At first glance, separation undoubtedly looks like a definite solution of the problem. But that is not so. There are a number of grade separations in Illinois, which when built were the last word in design, but which today are a greater hazard, and the cause of more highway accidents, than a grade crossing would be. Although we highway engineers do believe we have learned from past experience—although we think we are planning today more adequately for future requirements than we used to—I hesitate to say that what we are doing today will be good in 1960. No one can accurately forecast the development of our motor and highway industry so far ahead.

There is one important consideration with regard to grade separations that is often neglected: in eliminating the hazard of a grade crossing it is essential that no new hazard be introduced. Thus in planning a grade separation the utmost attention must be paid to the following: (1) Horizontal curves on the approaches should be avoided. Where the right-of-way or the physical conditions make this impractical, long curves with large radii must be used. (2) A minimum horizontal clearance of 32 ft for a two-lane highway and corresponding widths for four-lane highways must be provided. (3) Gradients on the approaches should be not more than 4 per cent. (4) Adequate sight distances should be provided, enabling the driver to bring his car safely to a stop before reaching an obstacle in his way. (5) Elimination of center columns in the roadway is very important. (6) Horizontal curves should have the proper superelevation. No compromise, regardless of cost, should be made on any one of these requirements.

There are two major types of grade separation, generally classified with reference to the highway traffic as overheads, or viaducts, and subways. Overheads should be planned to provide for future railroad expansion, while subways should be built to accommodate ultimate highway traffic. It is impossible to state which of the two structures is preferable. The railroads generally prefer an overhead, because a track structure is an added burden of maintenance. From the standpoint of a highway traffic or safety engineer a subway seems preferable; it permits continuity of pavement and shoulders, and shorter approaches for the same gradient with more sight distance. From the standpoint of the highway designer and the highway maintenance man, each type presents its difficulties, though the overhead is easier and cheaper to maintain. Taking everything into consideration, topography and local conditions generally determine the type of structure; and where an overhead and a subway are equally feasible, the relative economy in construction and maintenance is the most important guide to a decision.

Before leaving the topic of grade-crossing elimination, I would like to inject my pet idea on the subject. I am of the opinion that 30 per cent of the existing grade crossings in Illinois are superfluous, and could be closed with no inconvenience to the public. Though these unimportant crossings are carrying very little traffic, they are the scene of a very large percentage of the accidents. Only last February two serious train wrecks occurred at such points.



A Hazardous Two-Lane Grade Separation near Springfield That Has Been Revamped to Accommodate Four Lanes of Traffic Without Obstruction

I am glad to be able to report that activities to remedy this situation have actually started, and that within the next two years many of these crossings will probably be closed.

We come now to the second group of improvements, namely, grade-crossing protection. This group comprises six types: (1) fixed signs, (2) bells and locomotive whistle, (3) wigwag signals, (4) crossing watchmen, (5) floodlighting, (6) gates, and (7) flashers.

In the horse-and-buggy days a fixed crossbuck was a sufficient protection; today it is inadequate unless supplemented by advance warning signs. These signs—a round disk with a cross and the letters "R.R."—vary in location. In rural areas they are placed 500 ft from the crossing except under special conditions. In municipalities the sign is placed in the same block as the crossing but not less than 100 ft distant.

Progress has been made in developing reflectorized signs for both crossbucks and advance warning signs. Illinois has excellent highway markings on its primary road system, and all of its advance warning signs and most of its crossbuck signs are reflectorized. However, fixed signs are not very effective because the public does not pay much attention to them.

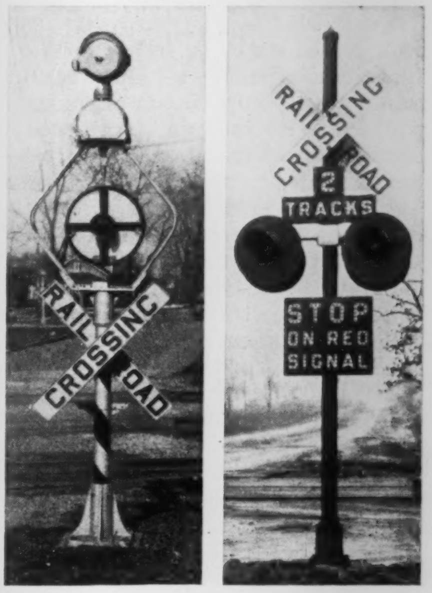
Bells were the first automatic warnings used at grade crossings; they were operated from a local primary battery and controlled from track circuits. With the noise of modern traffic and the prevalence of closed cars, they are entirely out of date.

The wigwag was the successor to the bell. It consists of a disk or banner mounted on a post approximately 7 ft high, with a red lamp in the center of the disk. Normally the disk is at rest and the red light out. Upon the approach of a train the light goes on and swings back and forth with the disk. Wigwags are not equipped with powerful lights, and hence the adequacy of this type of protection is somewhat questionable. Moreover, their mechanical apparatus requires more maintenance than the flashers. For these reasons new installations of the wigwag have been discontinued in Illinois on the primary road system.

A Well-Designed Grade Separation in Cook County, Providing a Clear Opening for Four Lanes of Traffic

Note the Long Span Required on Account of the Skew

As an outlet for incapacitated pensioners, the employment of a watchman for grade-crossing protection serves a useful purpose. However, the poor man can guard only one side of a train when it is on the crossing; he is not an object of high visibility; his lantern or sign does not compare in power and effectiveness with modern flashers; his services are more expensive than signals; and there is danger to his life in the performance of his duties. For these reasons the modern trend is towards mechanization of grade-crossing protection.

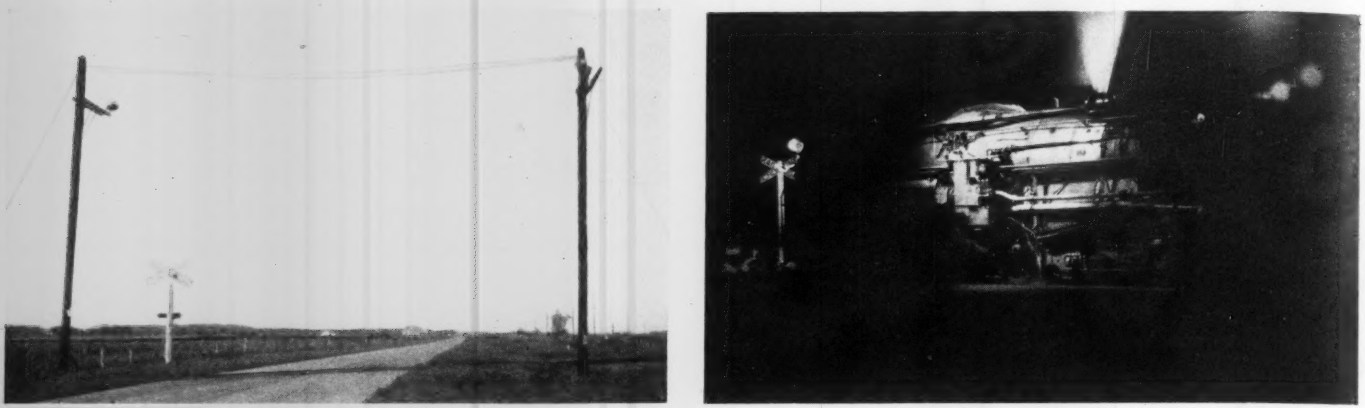


Two Types of Protective Devices—The Wigwag with Bell and the Standard Flashing-Light Signal

Visual protection, in the form of directional floodlighting at crossings, is quite effective in special locations. Where the gradient of the approaches is such that the headlights of an oncoming vehicle shine over or under the railroad cars, so that there is danger of automobiles running into the side of trains, it is the best possible protection. These floodlights, on high poles, are generally automatically controlled so as to illuminate the side of the trains, across the highway, without producing a glare in the eyes of the locomotive engineer or the motorist.

In Illinois the predominant type of grade-crossing protection for the last few years has been the flashing-light signal. It consists of two alternately flashing red lamps, 30 in. apart, mounted on a pole approximately $7^{1}/_{2}$ ft above the grade on the highway. There is one unit on each side of the track. Illinois laws require the lenses to be $8^{3}/_{8}$ in. in diameter and lamps to shine in both directions along the road, with a beam of the same intensity in the front and in the rear. In order to accomplish this, the modern installations are provided with a pair of lamps mounted back to back for each flasher light.

As long as any part of a train is within the limits of a track circuit separated by insulated joints, the relay is deenergized and the lights flash. The control circuits are so arranged that failure results not in the signal's going dead, but in a continuous flashing. There are practically no moving parts and there is no record of an accident in the state in which a signal of the present standard design failed to operate when it should have. At an open crossing the circuit is simple. However, switching, reverse movements, and stopping of trains may complicate the installation because it is important to eliminate false indications—that is, the operation of a signal when no train is on, or about to come on, the crossing. False indications tend to produce a disregard of the public for this protection.



FLOODLIGHTING INSTALLATION. THE LAMPS ARE SO ARRANGED THAT THERE IS NO GLARE IN THE EYES OF EITHER THE LOCOMOTIVE ENGINEER OR THE MOTORIST

The last type of protection mentioned in the classification is the gate. Gates can be operated manually, from a tower or from the ground; or automatically, by means of pneumatic apparatus, electric motors, hydraulic devices, and so forth. The gate is an especially desirable type of protection because (1) it places a warning directly in the path of traffic and, if properly lighted and properly operated, can hardly be overlooked by the driver; (2) it is a more compulsory stop; and (3) it will warn traffic in a situation where two trains are concerned, one just clearing the crossing, the second approaching it. The disadvantages of complicated equipment and the possibility of failure do not outweigh these advantages.

The most recent development of both manual and automatic type, and one which is considered by experts as the best possible type of protection, is the so-called short-arm gate in combination with flashing-light signals. The short-arm gate obstructs only the lane on the right-hand side of the center line of the road, and present experience indicates that accidents caused by drivers passing around the end of the arm are very rare. Trapping of cars between the gates is eliminated, and improvements permitting more regular and timely operation have been perfected. In combination with flashers this type of protection will still give the flasher warning in case the gate arm is broken.

It is not my purpose to discuss in detail the third major group of improvements—safety campaigning. Suffice it to say that the ground work which is being laid today in the schools will bring excellent results in the next generation.

I have yet to qualify my statement in the beginning that the problem of the highway-railroad crossing cannot be solved completely. In this connection let us look for a moment at the cost of the three most important types of protection. Fixed signs cost about $150 per crossing. Fashers average approximately $2,500 per crossing, or $3,500 in connection with short-arm gates. The cost of grade separations will vary from $20,000 to $1,500,000, with $75,000 for a good average. Now Illinois has approximately 18,000 railroad-highway grade crossings, of which only 24 per cent are protected by means of watchmen, gates, signals, or bells; and it is no exaggeration to state that only 5 per cent have truly adequate protection. Suppose we were to attempt to "solve" the problem.

Fixed signs would not help materially, as the records show. So passing over that type of protection we come to flashers as the next cheapest possibility. Multiply 18,000 by 2,500 and we arrive at the neat figure of $45,000,000. Even if the money were available it would not be sound economics to spend it that way. As for complete separation of all grade crossings in the state, the cost could be put roughly at $1,350,000,000—more than all the railroads in the state are worth. So even if spread over a long period, the separation of all grades is definitely out of the question.

RAILROAD CROSSING
4 TRACKS

GATES IN COMBINATION WITH FLASHERS

In the Newest Installations, the Crossbuck Is Reflectorized Like the "4-Tracks" Sign Below It

But that is not all. Whatever we do, we cannot eliminate the human element; we cannot make drivers stop taking chances. That is why I say that the problem cannot be solved completely. It is also why I dwelt on my pet idea of closing unimportant crossings. Barricades are very cheap.

Weather Bureau's Contributions to Hydrology

Need of Forecasts for Flood Control and Aviation Spurs Development of New Facilities

By WILLIS RAY GREGG
CHIEF, U. S. WEATHER BUREAU, WASHINGTON, D.C.

THERE are many ways in which the Weather Bureau has been—and can be, in increasing degree in the future—of assistance to the engineering profession. Particularly is this true in the study of hydrologic problems. In the present article Mr. Gregg reviews briefly the "slow but definite" trend of improvement in methods of weather forecasting. Then, after showing the relationship between meteorology and hydrology, he takes up a discussion of modern flood-forecasting. The paper concludes with an outline of the Weather Bureau's extensive plans for the future. This paper was originally presented by Mr. Gregg before a recent meeting of the Metropolitan Section of the Society.

ABOUT a century ago the development of the telegraph, the discovery of certain fundamental physical laws, and the introduction of instrumental apparatus, particularly the barometer and the thermometer, aroused a very active interest in the possibility of adapting weather service to human activities. Almost simultaneously many countries organized fairly extensive networks of observation stations and endeavored to use the data in predicting the weather a day or two ahead.

From that time on considerable progress was made in developing new and improved types of instrumental apparatus, in extending the range of observations, and in applying the data to problems of forecasting. Gradually observation stations were established over the entire country and even beyond, including Alaska and the West Indies. Simultaneously Canada, Mexico, and many other countries organized similar services, and the first steps were taken in effecting an international exchange of reports. Tremendous progress was made in this field with the introduction and use of radio, for this made it possible to receive data from ships at sea, one of the most important developments in the entire history of weather service. Through international conferences, arrangements were made for the adoption of uniform methods of making, recording, and publishing observations.

Meanwhile increasing attention has been given to the exploration of the upper air, concerning which practically nothing was known up to the beginning of the twentieth century. Kites and manned balloons had their day. They were succeeded by small free balloons, some carrying instruments, and most recently by airplanes which go up quickly to a height of three or four miles and bring down a complete record of temperature and humidity at all heights reached. The study of these records in the vertical, together with those in the horizontal, has led to important advances in forecasting.

IMPROVED FORECASTING TO MEET NEEDS OF AVIATION

Undoubtedly, the greatest impetus to the organization of this special type of service was given by aviation. For this activity it is vital that weather conditions be reported with great accuracy not only along the airways, but also for a considerable distance on each side in order that the development of unfavorable weather may be predicted before it reaches the flying routes. Moreover, general daily forecasts were found entirely inadequate. It was necessary to develop a new type, very definite in character, and covering a period about as long as that of the flight itself. Accordingly, for the most active airways there are now hourly reports from a dense network of stations, and six-hourly forecasts. There is room for much improvement, but within the funds provided, as rapid progress as possible has been made. With an additional appropriation recently made available, a further strengthening of the entire system is in progress.

Prior to the World War, forecasting was largely empirical and was based almost exclusively on observations of surface conditions and clouds. Later the Bjerkness cyclone model was introduced. This model, with its warm sector bounded by the warm front and the cold front, which meet near the center of lowest pressure in the cyclone, made it possible to explain the occurrence of most of our usual types of precipitation by the application of well-known physical laws. In more recent years, with the increased number of observations by airplane, it has been possible to obtain the characteristic properties of the air masses overlying great regions of our country with respect to temperature, humidity, and pressure. Studies of these air masses have permitted a clearer understanding of the inception of disturbances affecting weather as well as the different kinds of precipitation which attend them. Further, it is possible from the plotting of airplane data on energy diagrams to determine the instability of the air and to ascertain the amount of lifting, either by thermal convection or by frontal action, that is required to produce condensation. Such information becomes of great importance in the warm season in forecasting thunderstorms. Formerly it was necessary to depend on the ability of the experienced forecaster to determine when and where a disturbance would originate and how rapid would be its development. From investigations of upper-air data a great deal has been learned regarding the formation of "fronts" and the development of disturbances along them. This permits more accurate estimates as to when and where such disturbances will develop. Further, after a disturbance has once developed, recently devised kinematical methods, with the help of the geostrophic wind scale, assist in determining not only the direction and speed of movement but also whether there will be an increase or decrease in intensity.

It will be seen from the foregoing that although progress in forecasting is slow it is quite definite. We are confident that with further study of the increasing abundance of upper-air data this progress will be very much greater in the next few years than during all the previous history of meteorology. The recent rapid development of the radio-meteorograph will undoubtedly result in a marked improvement in forecasts of all types. This instrument (Fig. 1) is attached to a balloon and sends back signals of pressure, temperature, and humidity from heights well above those attainable by airplanes.

In the figure, the key, or contact, end of the instrument appears at the left. A vacuum cell (top, left) contracts or expands as atmospheric pressure increases or decreases; a strand of human hairs (bottom) shortens as the air around it becomes dryer and lengthens as it becomes moister; a bimetallic coil (lower right) twists tighter as the temperature drops and loosens as it rises. A tiny hand, or lever, with a spiral contact mounted on it, is attached to each of the sensitive elements, so that it moves in response to the element's movement. A small cam, kept in motion by special clockwork, revolves in the same plane as the spiral contacts, making contact with them as it goes. Every 30 sec the cam makes a contact with a fixed point in the plane. Each contact makes an electric circuit for a fraction of a second between the key part of the instrument and the transmitting part.

The transmitting end of the instrument appears at the right of Fig. 1. A miniature radio run by flashlight batteries, with its aerial running up along the cord that attaches the radiometeorograph to the balloon carrying it aloft, is hooked up with the key, or contact, part of the instrument. The electric circuit made by this contact part causes the radio to send a signal out over the air.

The relationships between meteorology and hydrology are many and close, but they may be considered under two general headings: (1) statistical relationships useful in determining long-period trends, and (2) current information, of vital importance in the rational solution of hydrologic problems and particularly in the development of improved flood-forecasting procedure.

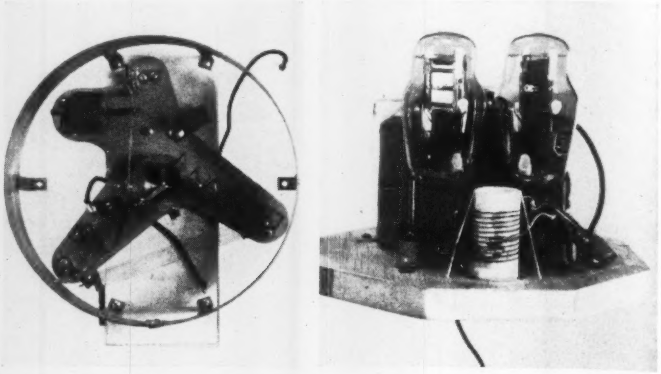
Taking up the statistical side first, the data that are accumulated over a period of years are of tremendous value in connection with many engineering problems. In this field, as in many others, effort is very properly being concentrated on securing maximum returns commensurate with maximum safety and minimum cost. It is well known that many engineering projects could be so constructed as to be indestructible, short of a cataclysm, if we were willing to forego economy and other practical considerations. It is believed that a conservative but effective reduction in safety factors in several fields of design can be secured through rationalized methods of applied hydrology. This objective alone will justify many times over, the cost of the planned expansion of the Bureau's hydrologic and statistical service.

Necessarily, the longer the period of observation the more definite the conclusions drawn from the data. It is essential therefore that we have records from individual stations extending over several rainfall cycles and thus providing an adequate basis for long-range forecasting. In this sense I use the term, "long-range forecasting," without specification as to time. This is a perfectly proper use of the term as such forecasting enables us to tell quite definitely what are likely to be the extremes in precipitation or any other element over a long period of time. On such information are based conclusions as to available supplies of water for irrigation, power, and ordinary uses.

BETTER RIVER FORECASTS FOR FLOOD CONTROL

The river-forecasting work of the Bureau is carried on at 56 centers throughout the country from which forecasts and warnings are issued to nearly 800 cities, towns, and communities. On the lower reaches of the principal rivers the Bureau has for many years accurately forecast and published, days and even weeks in advance, the approach of flood crests. On a large river like the Mississippi or the Ohio such a crest travels rather slowly—about 40 miles a day—so that there is usually ample time to correct and refine a forecast at downstream points before the crest arrives.

As the headwaters are approached, however, prediction of river stage becomes increasingly complicated. The amount and rate of the rainfall, the slope of the land and the stream channel, the character of the watershed and its cover, and the influence of antecedent rainfall—factors which have been integrated into terms of stage on the lower river—now become variables which must be dealt with separately and quantitatively.



U.S.D.A. Photograph

Fig. 1. Radio-Meteorograph, Newest Mechanical Weather Observer of the U. S. Weather Bureau

Our nation is rapidly becoming flood conscious, with the result that the Weather Bureau has been forced to extend its river forecasting service into the headwater areas of nearly all the principal streams. There has been neither time nor opportunity to prepare for basic changes which involve method and procedure wholly without precedent. At many important up-river stations, the forecaster has only a comparatively few hours to foretell the approach of a flood and that under the conditions of "flashy" stream flow typical of headwater tributaries. Pittsburgh is perhaps the best example of such a situation. Any plan to meet this problem must be prepared to predict flood stage practically as the rain falls and the snow melts. The city itself must be organized to evacuate certain areas with the precision of a fire department. Industry and business occupying danger zones must plan to waterproof against the rising water or to remove damageable goods to higher levels on minimum notice. This city, and other municipalities so situated, must maintain stand-by emergency water supplies and lighting facilities. Permanent concentration centers must be selected in advance and emergency housing provided. These and other plans in considerable detail are being formulated by the agencies charged with the responsibility of dealing with great floods.

The flood of January 1937 in the Ohio and lower Mississippi rivers illustrates the application of both approaches to the problem of flood forecasting. The forecasts for the Mississippi, for example, were almost entirely on the basis of upstream stages. Those for the Ohio on the other hand were based in considerable part on the occurrence of the heavy rain that prevailed for the greater part of the month, causing the upper river to crest 24 to 36 hours after the rain ceased.

The extremely heavy rainfall over the Ohio Valley and part of the adjacent areas, which produced this flood, was in general caused by abnormal pressure distribution over North America and adjacent waters. Practically the entire month of January was characterized by a deep area of high pressure in the vicinity of Bermuda and another over the Pacific Ocean west of our coast and northeast of the Hawaiian Islands. This pressure distribution brought about a strong influx of warm, moist air from the Gulf of Mexico over the Ohio basin, while air masses of polar origin moved southward almost continuously over much of the western and northern parts of the United States. These movements of polar air were accompanied by secondary areas of high pressure centering over the northern Great Plains. The warm air was forced to rise over the cold, which it encountered over the Ohio and lower Mississippi valleys from western Pennsylvania to eastern Texas. This rapid lifting of the very moist air of tropical origin resulted in abundant condensation and precipitation. The resulting flood has been described in detail elsewhere. The damage to property was incidental compared to the loss of life and dire human misery that ensued throughout the Ohio and lower Mississippi valleys.

Official Photograph, U. S. Army Air Corps

Accurate Forecasting Reduces Damages in Circumstances Like This—to Be Forewarned Is to Be Forearmed

Brookport, Ill., on the Ohio River, February 5, 1937

Snow was not a serious factor in this flood but very often it is. This is particularly the case if it has accumulated to a considerable depth when a spell of very warm weather, accompanied by rain, occurs. Even then floods ordinarily do not become serious unless the rainfall is fairly heavy. In other words, there is definite need for accurate and timely forecasting of rainfall, particularly in regions where rivers are small and of fairly steep slope, and where floods are "flashy." Headwater forecasting is now receiving the attention of the Bureau's hydrologists, and rapid gains are being made in applying the more recently developed conception of rainfall-runoff relationships to stream-flow estimation.

PLANS FOR THE FUTURE

We have already discussed the more urgent needs of engineers in the fields in which the Weather Bureau may be helpful. In order to meet these needs it has been necessary to reorganize the hydrologic branch of the service so as to bring about a much closer coordination with agencies in charge of flood-control programs and to permit greater participation in fundamental research. The more important features of the reorganization, which is being put into effect as rapidly as funds permit, will now be discussed.

One of the most pressing needs is to provide the forecaster with means of estimating tributary stream flow, quantitatively from rainfall. Accordingly, the country has been divided into nine hydrologic regions, five of which have recently been provided with regional offices and personnel. The regional offices are being manned by qualified hydrologic engineers who will gather data, develop methods of estimating stream flow, devise means of assembling flows, and coordinate and unify the forecasting program.

The necessity to organize promptly for an expanded service in important headwater areas has been recognized by the Commonwealth of Pennsylvania. A project in which the state, the Geological Survey, and the Weather Bureau cooperate, has as its objective the development of modern forecasting methods for the streams of the state. Among the first steps has been the establishment of an almost completely new hydrologic data-base. It is now generally understood that the newer hydrologic methods of estimating stream flow from rainfall cannot utilize published rainfall and stream-flow records as 24-hour averages. Accordingly, 130 recording rainfall stations and about 15 additional stream-flow stations have been established on the watersheds of the Allegheny, Monongahela, Susquehanna, and Delaware rivers.

It is interesting to note that, including the 500 recording rainfall stations recently established on the Muskingum watershed, there is now a continuous net of closely spaced recording rain gages covering the greatest area so served in this country. This net, if extended west to include the Scioto and Miami conservancy districts, would provide a record of short-duration rainfall north of the Ohio River from the Delaware River to Indiana.

Also of interest are the hydro-meteorologic studies recently inaugurated cooperatively with the Corps of Engineers to estimate spillway and waterway capacities. The procedure of transposing storms for the purpose of estimating limiting flood flows is gaining favor among those responsible for the design of spillways and waterways. The studies referred to will undertake to determine regional storm potentialities for the country as a whole, and to develop a technique of storm transportation.

The unusual interest in hydrology manifested in recent years has created a difficult situation for the Weather Bureau. Formerly there was an occasional call for the continuous records of rainfall kept at our first-order stations. However, such recent developments as the unit-hydrograph, the idea of transposing storms, and the acceleration of general hydrologic research have created a demand for a more complete source of hydrologic data than now exists. A long-range plan, the first step of which we hope can be taken within the next year or two, provides for the establishment of nearly 3,000 additional recording rainfall stations.

The gathering of evaporation data has for many years been a responsibility of the Weather Bureau, and it maintains nearly sixty Class A evaporation stations throughout the country. The limitations of the data in terms of the loss from a shallow pan are fully appreciated. Current interest on the part of engineers and others, it is hoped, will stimulate the development of a more scientific method of measuring evaporation and provide funds to put it into effect.

Our river service, in its expansion in the West, is making effective gains in the development of improved methods of measuring rainfall. Hydrologic research was recently begun in Yellowstone Park, where basic relationships between snowfall, snow-melt, temperature, ground-surface conditions, and runoff are to be studied on three selected watersheds.

These are some of the main features in our reorganization plans. Although they relate mostly to the future, some of them already are in operation to some extent. Experience thus far assures us that, when fully worked out, they will result in very decided improvements in the service that the Weather Bureau provides to those engaged in the solution of hydrologic problems.

Engineering Education in the Southeast

History of Georgia School of Technology Illustrates Development There and Throughout the Country

By F. C. Snow

Member American Society of Civil Engineers
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In the not-far-distant past engineering knowledge was handed down from master to assistant or apprentice, as in the crafts. The first civil engineering curriculum in the United States was established at Rensselaer about a century ago. But it was not until after the Civil War that the expansion in railroad and factory building created any general demand for engineering schools. After relating the history of the Georgia School of Technology, Professor Snow continues with some very interesting reasons for the great strides in engineering education that have been made in recent years. His original paper, of which this is an abstract, was presented before the opening session of the Society's Spring Meeting in Jacksonville, Fla., April 20, 1938.

ENGINEERING education has progressed in the Southeast in much the same way as in other parts of the country—for it is the job of engineering schools and their graduates to solve the problems of engineering, and these problems cannot be divided into geographical districts. Nevertheless it may be of value, in tracing the progress of engineering education, to center attention first on one particular section of the country, and it is with the Southeast that I am most familiar.

Seventy years ago the war was over and the Southeast was entering upon that slow, trying period of recovery. The future of higher education looked dark, but it was brightened considerably by two generous gifts: Commodore Cornelius Vanderbilt, a New York rail and steamship owner, donated $1,000,000 to establish Vanderbilt University at Nashville in 1873, and in 1875 George Peabody, a Massachusetts financier, gave $3,500,000 to Southern education, part of which was used to build Peabody College for teachers in the same city. Engineering was given a place in Vanderbilt's curriculum.

For the most part engineering schools were made a branch or division of a university, and with few exceptions were established on the university campus with the other divisions. The Georgia School of Technology is an exception to this rule, but as its story in general does not differ from those of the other Southeastern engineering schools, I am offering it as an illustration.

THE BEGINNINGS OF GEORGIA TECH

About sixty years ago two Georgia law partners, Walter B. Hill and Nathaniel E. Harris, decided that every lawyer should have a hobby to relieve the strain of business. Mr. Hill chose prohibition for his hobby, while Mr. Harris decided upon the establishment of a technical school. Using his hobby as a platform, he ran for the legislature and was elected. He succeeded in getting a committee of seven, of which he was chairman, appointed to investigate the possibilities of establishing an engineering school. This committee, later increased to ten, brought in a favorable report in 1883. However, opposition developed and it was not until his second election that Mr. Harris was able to get his bill passed. Thus, by 1886 the Georgia School of Technology had been established by law.

Meanwhile, in a beautiful old building on the campus of Old Oxford College, in the quiet little city of Oxford, Ga., Dr. J. S. Hopkins, a preacher and a former scout in the Confederate army, had his office and his shop. On this same campus, in another building, Alexander Means first showed to mankind the illuminating possibilities of electricity. As Dr. Hopkins taught he worked in his shop. He knew the condition of the South, mainly agricultural and crying for industrial development. He dreamed of a school where boys could be taught practical as well as classical knowledge. What did the South need more than well-trained engineers? His classical friends laughed at him. The idea of elevating blacksmithing, the work of slaves, to the equal of the classics, was unheard of—it could never be done. But Dr. Hopkins, the combination professor and mechanic, a technical school in himself, became the first president of the Georgia School of Technology. In 1888 this institution opened the doors of its two buildings, one for shops, the other for administrative purposes and classrooms, to 125 students, all from Georgia.

There were six members of the faculty, four shop foremen, and the president. Legislative act required the school to teach the principles of science, especially those relating to the industrial and mechanical arts. The curriculum carried mathematics, physical sciences, English and drawing, along with plenty of shop work so that students would be able to earn a living upon graduation. The state appropriated $20,000 a year, and the city of Atlanta, where the school was located, $2,500. No tuition was charged to residents of Georgia, but outsiders had to pay $150 a year. There was a $25 expense fee, and the catalog of 1888 suggested that the student should bring with him such scientific books as he had.

The only degree conferred was bachelor of science in mechanical engineering. There were four classes—apprentice, junior, middle class, and senior. It was intended that the four-year course should be followed by a graduate course of two years, leading to the degree of mechanical engineer. Entrance requirements were that a boy must be not less than sixteen, of good character, and must pass entrance examinations in arithmetic, English, and geography.

In 1890 a sub-apprentice course of a year was added to prepare students for the apprentice class. Two degrees were conferred in that year, 9 in 1891, and 63 in 1892. The civil and electrical engineering courses were added in 1896, the textile in 1899, chemical in 1901, architecture in 1908, cooperative-plan work in civil, electrical, chemical, and textile in 1912, ceramic engineering in 1924, and aeronautical in 1930.

The Experiment Station has not been in operation very long but is doing good work. One project of interest to civil engineers, although a textile research, resulted in the development of a loosely woven cotton rope to replace the unsanitary jute for calking water pipe. Thus another use for cotton was provided and a means of contaminating water mains was eliminated.

The present value of the school is placed at $2,342,000.

In 1937 its expenditures were $567,000; its enrollment was 2,948; and the number of degrees conferred in June 1937 was 232. There are 135 members of the faculty.

Such is a cross-section of the progress of engineering education in the Southeast. It has felt its way along, keeping abreast, or possibly a little ahead, of the demands that industry has made upon it. It has usually needed more money, but has produced results on what it had.

REASONS FOR PROGRESS IN ENGINEERING EDUCATION

Now I want to call attention to several things which I believe indicate progress in engineering education, or reasons for it. First, I would list the well-educated, hard-working engineering teacher, who by acting as consulting engineer for industrial firms, by engaging in practical work during vacations, and by studying new methods and processes, has kept well informed as to the needs of industry. He is making it his job to pass on this information to his students and to study with them ways of meeting these needs.

Second, I would list the fact that students are year by year getting better—in their attitudes towards their work; in their grasp on affairs; in their ability to talk before people. The task of teaching them has become easier, so that the teacher, in the practical courses at least, can assign a project and leave a student pretty much on his own resources in the development and completion of the required report or design. Thus the student approaches the manner in which he must work after graduation—but with this difference, that the teacher must keep in sufficient contact to see that no absurd conclusions are reached, and no glaring errors in method introduced. Misunderstandings must be cleared up by lecture and quiz

Perhaps the explanation for the improvement in students lies in the improved methods of student selection. The cost of an engineering education to the college and to the student is high. If a student can be convinced, early in his college course, that he cannot graduate in engineering with high enough grades to get a job, or that his talents are along other lines, his time is saved, and the money which he and the college would spend for his education can be used to better advantage. Studies in high school performance coupled with examinations at entrance, and grades made in the freshman class, offer an accurate means of predicting future performance. Sometimes they indicate the removal of a student not fitted for an engineering career, at other times the lightening of a schedule, repetition of a course in which a low grade was made, or possibly advice to the student to get a job and work for a year or two before finishing his college course. "Freshman orientation" helps the beginning student to grasp the meaning of the various divisions of engineering, to detect what he must do to adjust himself to changes in methods of teaching from high school to college, and often saves a freshman from dismissal.

Another sign of progress is that the engineering school, while still concerned with teaching the application of science to everyday life and with preparation for making a living—is telling its students in no uncertain terms that they must serve others if they would be successful. Along with a knowledge of engineering and science, they must have certain qualifications, such as power to manage the work of others; ability to make themselves liked by their associates; personality, which compels people to listen to them; and above all, honesty, politeness, good appearance, and real character. I doubt the ability of any engineering school to build these things into a boy in his four years of college, but his teachers can, through example and precept, keep them continually before him. Surely the personal qualities a student should develop while working for a degree are in no way different from those he needs in business.

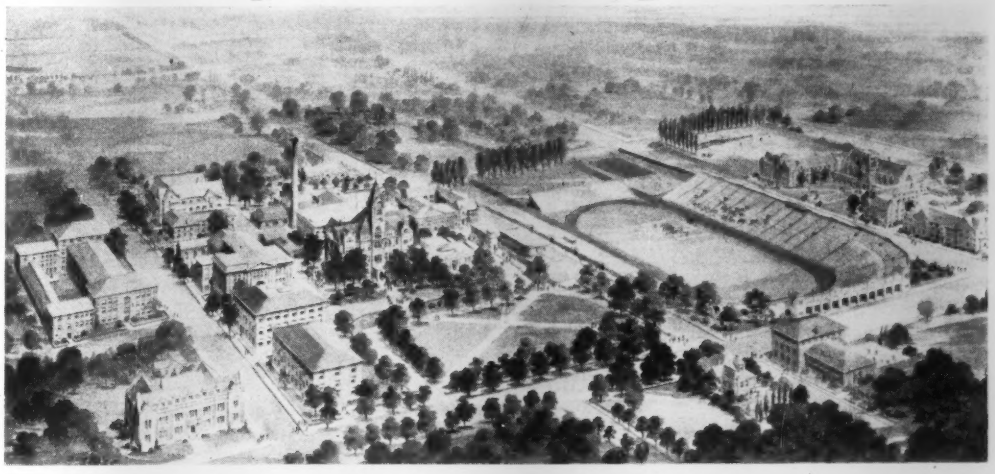
Improvement can also be noted in textbooks, in the subject matter of courses, and in methods of presentation. Teachers no longer believe that all boys are alike, that all must be shaped in the same form. They are giving individual instruction fitted to individual patterns.

Likewise, progress has been made in the manner of measuring a school's success. It is the problem of the engineering college to turn out graduates who will fit into industry. The policy of rating a school by its size, the number of its graduates, its enrollment, or the amount of its endowment is gradually being educated out of the general public, and the ability of graduates to make first-rate engineers in practice is taking its place as the real measure of a school's success.

The practice of licensing professional engineers is a distinct step towards progress in engineering education because the passing of the required examination will be difficult for the man without college training. Such licensing indicates that the majority of engineers' jobs of the future are to be held by college graduates. It offers a guarantee that professional engineers will not be compelled to compete with self-styled engineers who work cheaply and produce inferior results.

PART PLAYED BY NATIONAL ENGINEERING SOCIETIES

It would be unjust to cite progress in engineering education without mentioning the various national engineering societies. They have been of great aid in many ways, one of which is the formation of student chapters at the colleges. Nor can we forget the Society for the Promotion of Engineering Education. It has helped in standardizing subject matter, in establishing curricula, and in numerous other ways. The latest organization to enter the field is the Engineers' Council for Professional Development. Possibly its greatest help has been its accrediting of engineering schools and courses, its suggestions for the handling of students, its lists of engineering books, and its help to graduates.



Campus of the Georgia School of Technology, Atlanta, Ga.

New Life for Old Railroad Bridges

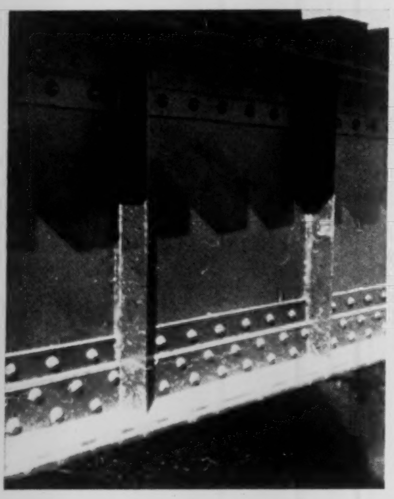
Thirty-Year-Old Steel Spans Strengthened to Take E-60 Loading

By George G. Thomas

Member American Society of Civil Engineers
Engineer of Metal Structures, Atlantic Coast
Line Railroad, Wilmington, N.C.

A combination of welding and riveting is being used on the Atlantic Coast Line Railroad to put a number of old steel bridges in shape to meet the demands of modern rail traffic. How the strengthening was accomplished, without so much as a single "slow-order," is told here.

Last year (1937), when the Atlantic Coast Line Railroad purchased a number of 4–8–4 type locomotives with 65,000-lb driving-axle loads, it became necessary to strengthen several small steel bridges that had been in service for thirty years or more. Originally designed for Cooper's E-40 live load, they would have been seriously overstressed under the new conditions.



Girder Span, Showing New Cover Plates and Additional Flange Plates and Rivets

The structures involved include one double-track through-truss span (102 ft in length between end bearings) and 37 single-track deck-girder spans varying from 30 to 74 ft in length and aggregating 1,575 lin ft. They are all located on the main line, between Richmond, Va., and Jacksonville, Fla., and between Waycross and Albany, Ga.

Previous experience of the Metal Bridge Department clearly indicated that a combination of electric welding and riveting would be the most practical and economical method to follow in applying the reinforcement. The program as adopted has required a labor force consisting of a foreman, 16 men, and a cook. Four men are kept in the bridge yard fabricating the steel, while the remainder comprise the field crew. The field equipment includes two 300-amp direct-current electric welders and one 160-cu ft air compressor.

Preliminary engineering for the program consists of (1) field inspection of each span; (2) mathematical analysis of the stresses in each span; and (3), determination of the reinforcement needed in main sections or details. Complete detail drawings are prepared for use of the bridge yard force in fabricating the reinforcement, and the same drawings are then used as a guide for the proper application of the new material. The analysis of stresses is made in accordance with the Rules for Rating Existing Iron and Steel Bridges, 1936, of the American Railway Engineering Association. These rules are supplemented by the Specifications of the American Welding Society, 1936, for the Design, Construction, Alteration, and Repair of Highway and Railway Bridges by Fusion Welding.

A detailed description of the work at two bridges will suffice to illustrate the methods employed at all sites. For our first example, let us consider the 30-ft deck-girder span shown (with the new reinforcing) in Fig. 1.

Like all the others, this bridge had been designed for Cooper's E-40 live load. The computed stresses for the new locomotives showed the following parts of the span to be deficient:

1. Flange area, owing to original design and to rusting and mechanical wear during 33 years of service
2. Strength of rivets connecting flange angles to web
3. Bearing area of end stiffener angles
4. Top laterals and cross frames

In the lower right corner of Fig. 1 is an end view of the girder before reinforcing, showing the original flange section composed of two angles per flange, without cover plates. The deficiency in flange area (Item 1) was compensated by applying 14 by $^3/_4$-in. cover plates to the top and bottom flanges and securing them to the original flange angles by welding. Attention is called to the development in the strength of the new cover plates by continuous fillet welds at the ends, followed by intermittent interior fillet welds 3 in. long.

Before applying the top cover plates it was necessary to chisel out the daps in the wooden ties to allow for the

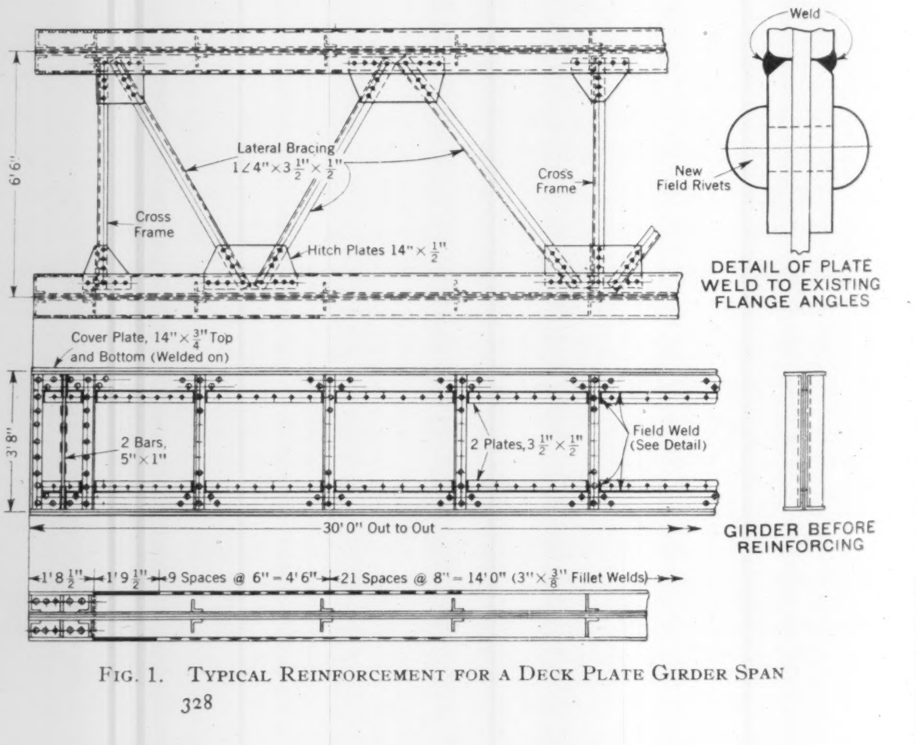

Weld
Lateral Bracing 1∠4"×3½"×½"
Cross Frame
New Field Rivets
6'6"
Cross Frame
Hitch Plates 14"×½"
DETAIL OF PLATE WELD TO EXISTING FLANGE ANGLES
Cover Plate, 14"×¾" Top and Bottom (Welded on)
3'8"
2 Bars, 5"×1"
2 Plates, 3½"×½"
Field Weld (See Detail)
30'0" Out to Out
GIRDER BEFORE REINFORCING
1'8½"
1'9½"
9 Spaces @ 6" = 4'6"
21 Spaces @ 8" = 14'0" (3"×⅜" Fillet Welds)

Fig. 1. Typical Reinforcement for a Deck Plate Girder Span

additional flange width. This was done without disturbing the track. The entire deck was then raised off the top of one girder at a time, and the new top-flange plate was placed and firmly clamped to the flange angles. After lowering the deck onto the new plate, the same operation was carried out on the opposite girder. The weld fillets were then applied, the work proceeding without interruption except during the actual passage of trains. None of these steps involved any interruption to traffic.

The new bottom cover plates were installed without difficulty. C-clamps were used to secure them to the original bottom-flange angles until the weld fillets had been completed.

The deficiency mentioned in Item 2 was made up by increasing the width of the vertical legs of the flange angles by means of $3^1/_2$ by $^1/_2$-in. plates, which were first riveted to the girder web and then welded to the upstanding leg of the original flange angles. Special care was taken to prevent the weld bead and the web from touching, as only by keeping them separated can the original flange-angle rivets be reinforced by the new rivets through the plates. The new plates were drilled at the bridge yard, and were used as templates for laying off holes in the girder webs that were drilled in the field.

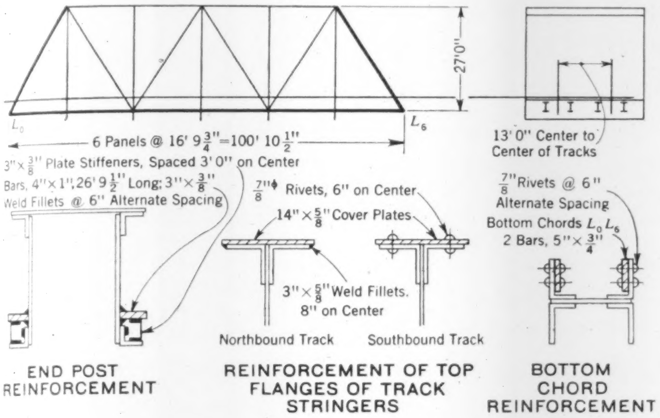
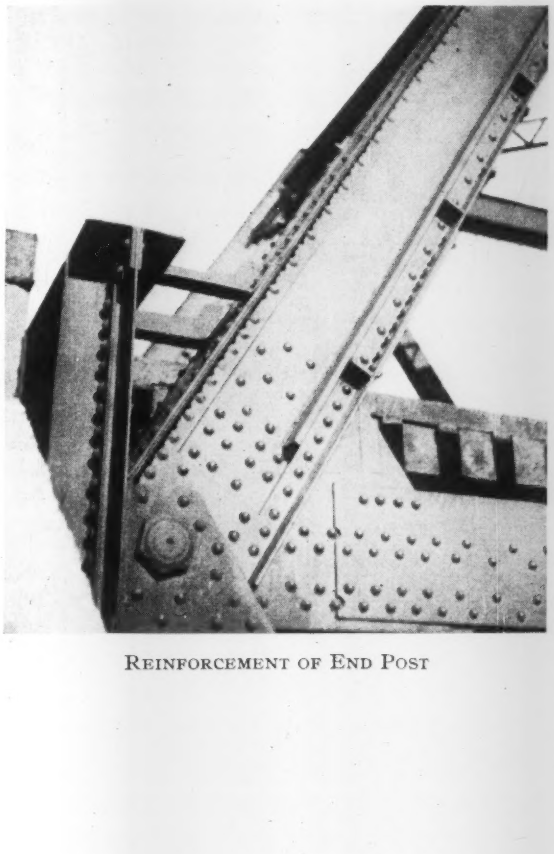

27'0"
L_0
L_6
6 Panels @ 16' 9$\frac{3}{4}$"=100' 10$\frac{1}{2}$"
13' 0" Center to Center of Tracks
3"×$\frac{3}{8}$" Plate Stiffeners, Spaced 3' 0" on Center
Bars, 4"×1", 26' 9$\frac{1}{2}$" Long; 3"×$\frac{3}{8}$" Weld Fillets @ 6" Alternate Spacing
$\frac{7}{8}$"ϕ Rivets, 6" on Center
14"×$\frac{5}{8}$" Cover Plates
3"×$\frac{5}{8}$" Weld Fillets, 8" on Center
Northbound Track
Southbound Track
$\frac{7}{8}$" Rivets @ 6" Alternate Spacing
Bottom Chords $L_0 L_6$ 2 Bars, 5"×$\frac{3}{4}$"
END POST REINFORCEMENT
REINFORCEMENT OF TOP FLANGES OF TRACK STRINGERS
BOTTOM CHORD REINFORCEMENT

Fig. 2. Reinforcement for a Double-Track Through-Truss Span

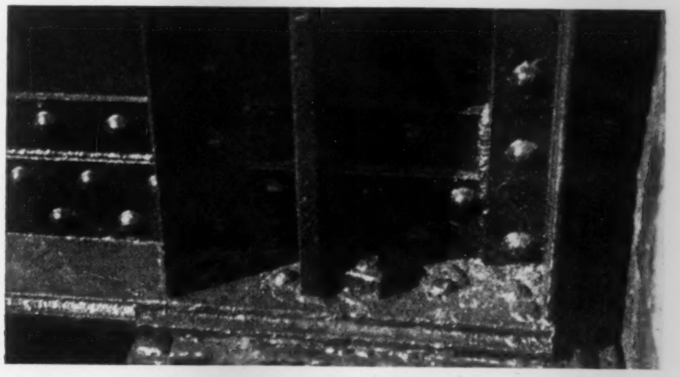
The deficiency in the end stiffeners (Item 3) was rectified by welding pairs of 5 by 1-in. vertical bars directly to each girder between the original end stiffener angles. The material for these bars came from a stock of eye-bars salvaged from pin-connected truss spans previously removed from service.

The renewal of top laterals and cross frames (Item 4) required the installation of heavier angles and plates than those originally used. Riveted connections were used because the original rivet holes were available in the girders, and because both welding machines were busy on other parts of the job. The track was jacked up between trains to provide clearance to drive the new rivets.



Reinforcement of End Post

As a second example, let us consider the 102-ft double-track through-truss span shown in Fig. 2. The computed stresses for the new locomotives showed that the span needed reinforcement in the bottom chords and in the inclined end posts. Field inspection showed also that the outstanding legs of the top-flange angles of the track stringers had bent downward under the ties. The material for reinforcing the bottom chords and end posts was taken from a stock of salvaged eye-bars. The material for repairs to the stringer flanges was new.



Reinforcement of End Stiffeners

In Fig. 2 the end post, with reinforcing, is shown in cross-section. A total of 8 sq in. of section was added by means of the two 4 by 1-in. bars set edgeways against the web plates and stitch-welded in place as close to the bottom flange angles as possible. The 3 by $^3/_8$-in. plates serve as stiffeners to hold the reinforcing bars in position.

The bottom-chord reinforcement added 6 sq in. net to each bottom chord. The 5 by $^3/_4$-in. bars were riveted, rather than welded, in order to develop the new material at the joints of the truss. Riveting of these plates left the welding machines free for the end-post reinforcement, and also permitted the new bars to be secured continuously across the joints. Splices were at points in the panels away from the joints.

The new cover plates on the tops of the track stringers provide an actual excess of metal. Their use is justified, however, (1) because the addition of the plates was made onto the top of the existing flange angles with no delay to traffic, and with no breaking of the track, and (2) because the $^5/_8$-in.-thick plates were of such stiffness that the bent legs of the flange angles were pulled straight by the C-clamps or the fitting-up bolts. The 14-in. width of the new cover plates provides the required width for weld beads on the lower side of the plate at each edge. Also, by projecting beyond the angles, the new plates protect them.

It will be noted that the plates added to the stringers on the northbound track were welded to the flange angles, while those on the southbound track were riveted. This permitted the work to progress simultaneously on the two tracks.

The reinforcement program outlined here was carried out under the direction of J. E. Willoughby, M. Am. Soc. C.E., chief engineer, Atlantic Coast Line Railroad.

All-Steel Exhibition Building in Germany

Steel Roof Plates Function as Load-Carrying Members in Arches of Unusual Design

By H. ORBANOWSKI

JUNIOR AMERICAN SOCIETY OF CIVIL ENGINEERS
BERATUNGSSTELLE FÜR STAHLVERWENDUNG, DÜSSELDORF, GERMANY

UTILIZING the "stressed skin principle," German engineers last year designed an all-steel exhibition building that is characterized both by its economical use of material and its ability to resist damage from aerial bombardment. Its chief structural feature is a series of six hollow arches whose principal members are corrugated plates. Mr. Orbanowski here describes the building and the methods used in erecting it, and touches briefly on the tensometer tests made on one of the arches.

AT the exhibition, "Schaffendes Volk" (A Nation at Work), in Düsseldorf, Germany, in 1937, the most imposing structure was doubtless the exhibition hall that housed the main steel exhibit. Whereas in ordinary steel buildings of this type the construction elements are divided into two classes—those transmitting the loads to the foundations and those serving as roofing and walls—the Düsseldorf structure used one and the same element, a corrugated steel plate, for load transmission and as roofing. This design, employing the "stressed skin principle," permits a considerable saving in material.

An intended later use of the hall dictated that its clear span should be in the direction of the major axis. Accordingly the main building (Fig. 1) has a width of about 280 ft and a length of about 148 ft. There is a two-story annex at each side. The supporting roof structure consists of six adjacent, hollow, two-hinged arches of triangular cross-section, built up of steel plates. Each arch is provided with a tie-rod (in the form of an H-beam) to take the horizontal arch thrust. As the six units are entirely independent of one another, the length of the hall can readily be increased by erecting additional arches.

The arch plates are subject chiefly to compression forces due to direct arch compression and to bending. To preserve their elastic stability they are corrugated, each corrugation having the shape of a trapezoid. The trapezoids act as columns, and to prevent their failure in buckling their effective length is reduced by transverse stiffening frames on about 19-ft centers. These frames in addition preserve the form of the arch, and their web members serve the dual purpose of transmitting the weight of the tie-rod and the load of a crane to the arches.

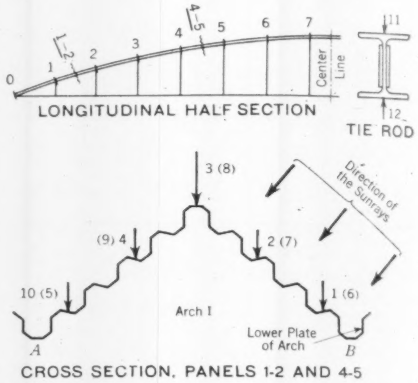


FIG. 2. LOCATIONS OF TENSOMETERS ON ARCH NO. 1

In the Cross-Section, Open Figures Refer to Tensometers in Panel 4–5, and Parenthesized Figures to Those in Panel 1–2

The connection between roof plates and tie-rod is taken care of at each end of the arch by a triangular steel bearing, the tie-rod acting in the center of gravity of the triangle. The bearings at one side of the building rest directly on the columns, while those at the other side are provided with rollers to allow the arches and tie-rods to move freely under the influence of loads and temperature changes.

The arch triangles have a base of 24 ft 6 in. and a height of 9 ft 6 in.; the trapezoidal corrugations have a wave length of 37 in. and a height of 7 in. The roof plates in general are $^3/_{16}$ in. thick. They were bent cold from steel sheets, each sheet giving one corrugation. To facilitate the field work, the bent plates were then welded together in pairs along a longitudinal joint to form one construction element. Welding was not used in the field, as the structure was to be dismantled at the end of the exhibition and reerected elsewhere. The transverse field joints are all riveted, while the longitudinal joints are bolted.

As it would have been extremely difficult to bend the plates to fit the theoretical arch, the theoretical center line of the arch was replaced by a polygon, each side having a length of 18 ft 11 in., the length of one plate.

In addition to the economical use of material, the design just described has several other important advantages, particularly its ability to resist serious damage from air raids. The thickness of the plates is such that the roof will not be pierced by ignition bombs, and there are no outstanding supporting members whose destruction would cause a collapse of the

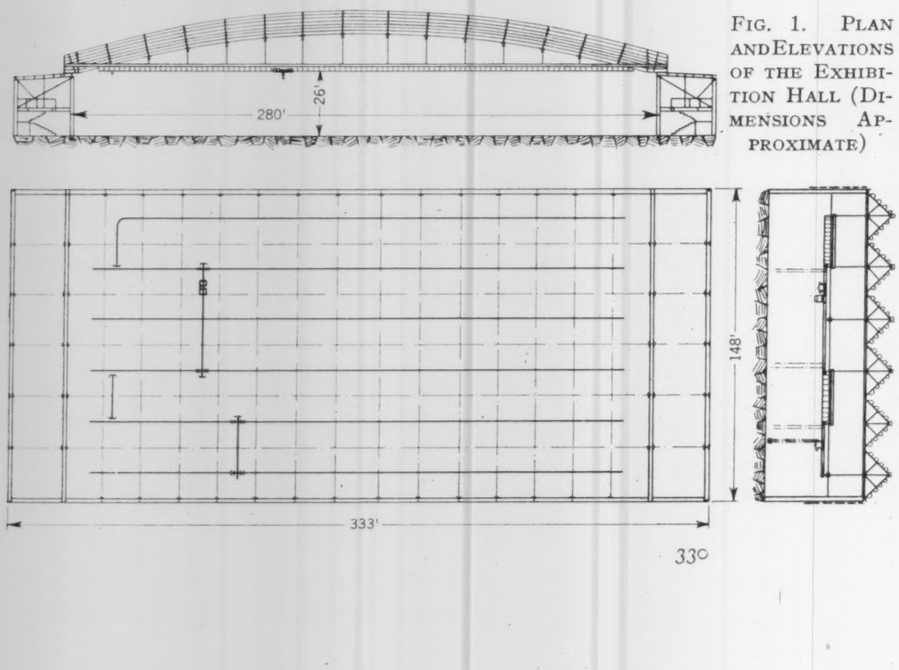


FIG. 1. PLAN AND ELEVATIONS OF THE EXHIBITION HALL (DIMENSIONS APPROXIMATE)

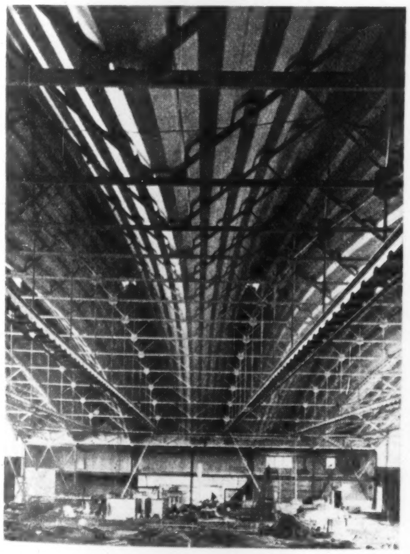
structure. Owing to the two-dimensional load distribution of the roof structure, damage to the roof plates will not cause a failure of the arches.

Because of the tie-rods, the arches are statically determinate with respect to outside forces, and the two-story annexes which serve as supports are subject only to the vertical reactions from the loads and to wind stresses.

With respect to the inner forces, the arches are statically indeterminate to the first degree. Stress analysis was based on the theory of elasticity, the method of deflections being applied, with the stress in the tie-rod introduced as the unknown. Dead weight, crane loads, snow and wind loads, and a temperature difference of ± 35 C between arch and tie-rod, were taken into account. The arches were regarded as circular arcs, and each arch was examined separately, neglecting the effect of those adjacent. All tie-rods were given an additional tension above that due to the loads, to relieve the stresses in the arch by creating a bending moment opposed to the moment due to the loads.

THE MAIN EXHIBIT HALL OF THE GERMAN IRON AND STEEL INDUSTRY AT THE DÜSSELDORF EXHIBITION

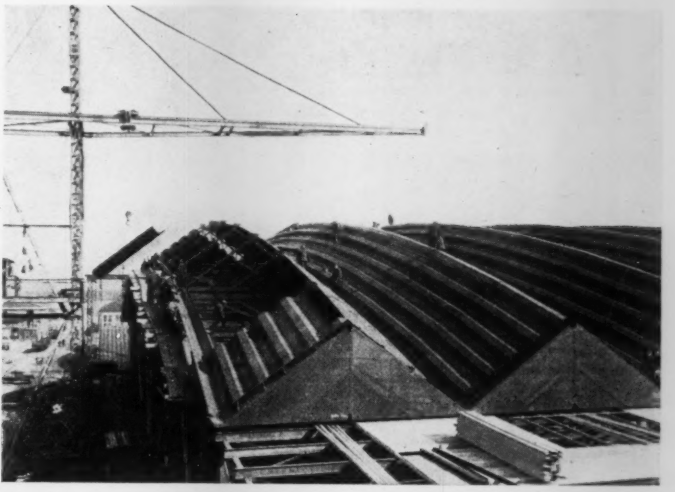
The two end arches are provided with diagonal wind bracing at the bottom of the triangular section, to transmit to the supports the horizontal components of the wind forces on the front and rear walls. In designing this bracing it was assumed that one-half of the force on either wall would be transmitted to the opposite end of the building by the lower chord of the stiffening frames.



AN INTERIOR VIEW, SHOWING ROOF PLATES, TIE-RODS, BEARINGS, AND STIFFENING FRAMES

The Rollers Supporting the Bearings May Also Be Distinguished (at the Tops of the Columns)

The framework of the front and rear walls of the building consists of I-columns and cross-bars. The columns are fixed at the bottom and simply supported at the top, allowing the roof structure to move freely yet serving to transmit the horizontal wind forces on the walls to the foundations and the diagonal wind bracing in the arch. The lower part of the wall is built up of $^1/_8$-in. steel plates, flanged at the four sides and bolted to the cross-bars of the frame; the upper wall is of wire glass.



ASSEMBLING THE CORRUGATED ROOF PLATES WITH THE TRAVELING JIB CRANE

A 2-ton electric crane was installed in the hall to aid in the erection of the small steel plant and rolling mill which were in operation during the exhibition. By providing one crane bridge between two tie-rods, another between three tie-rods, and two stationary connecting girders at the end of the hall, practically all points in the main building can easily be reached by the trolley (Fig. 1). The crane track is not rigidly attached to a floor or to columns, as in the customary type of installation, but is clamped to, and freely suspended from, the tie-rods. Thus the wheel flanges cannot catch if the bridge should twist slightly.

Considerable difficulty was encountered in the foundation work, as the land along the Rhine where the exhibition was to be built had only recently been reclaimed and filled in. In addition to this, two of the main foundations and four of the smaller ones were located directly above a sewer 10 ft 6 in. in diameter. The four small foundations were placed on a reinforced-concrete slab to distribute the load, while to support the two main foundations a reinforced-concrete bridge was built over the pipe, some 21 ft beneath the floor level.

Steel erection was commenced on February 1, 1937, and the last roof plate was attached 43 days later—a fast schedule by European standards. The two annexes were each erected with a stationary derrick crane. For the main structure a traveling jib crane with a fixed boom was used, the length of the jib being sufficient to assemble the roof plates for two arches at the same time. The procedure followed in erecting the arches is worthy of a detailed description.

After the annexes had been completed, a wooden scaffold with an upper chord of I-beams parallel to the center line of the arches was constructed. The lower chords of the stiffening frames for the first two arches were then placed on mechanical jacks on the upper chord of the scaffold and adjusted to the exact height. Next the stiffening frames of the first two arches and the wind bracing of the first arch were assembled. The tie-rods were suspended from the scaffold and the steel roof plates were put in place and riveted down. Then the traveling crane was moved; a scaffold was put up for the next two arches; and the process was repeated.

A GENERAL VIEW OF THE SIX ARCHES

Originally it had been planned to release the six arches simultaneously. However, to facilitate the work below, it was found necessary to remove the scaffold of each arch as soon as possible. At the center splice of each tie-rod a hydraulic jack was installed to give the tie an additional tension of 30,000 lb above that due to the dead load, and thus relieve the bending stresses. After four arches had been completely erected and the fifth arch assembled, the first step in releasing the arches was taken by stressing the tie-rods as follows:

Arch No. 1: 100% of tension due to dead weight + additional tension
Arch No. 2: 67% of tension due to dead weight + additional tension
Arch No. 3: 33% of tension due to dead weight + additional tension
Arch No. 4: 0% of tension due to dead weight + additional tension

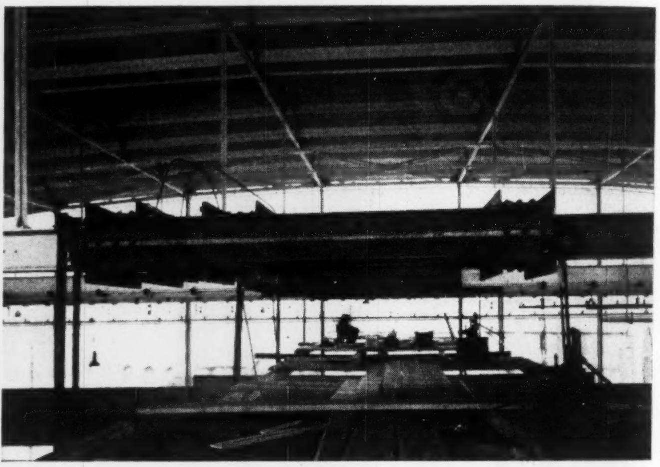
Now the first arch could be released and the scaffold removed. After completion of the fifth arch the stresses in the tie-rods of Arches 2 to 5 were increased to correspond to those just given for Arches 1 to 4, and the scaffold of the second arch was removed. This process was repeated till all the tie-rods had been given their final stress values.

Only one side of the center splice of the tie-rods was drilled in the shop. The holes of the other side were drilled on the site after the full stress had been attained. Then the two halves were rigidly joined with straps and the hydraulic jacks removed.

The theoretical deflection of the end of the center arches due to the additional tension of 30,000 lb in the tie-rods amounted to $1^{27}/_{64}$ in. towards the inside. Had the arch been released without stressing the tie-rod additionally, the deflection due to dead load would have amounted to $1^{1}/_{32}$ in. towards the outside. But as the tie-rod was stressed simultaneously with the release of the mechanical jacks supporting the arch, these two processes were superimposed.

After the roof plates of all six arches had been riveted down, the actual stresses in the plates of Arch No. 1 were examined by taking tensometer readings. During the examination, the tension chords of the other arches were given about the final tension due to dead load and additional tension, the hydraulic jacks in the center of the tie-rods not yet having been removed.

The locations of the 12 observation points are indicated in Fig. 2, and the data are presented in Table I. The distribution of stress over the cross-section of the arch is seen to be in good agreement with the results of the stress analysis. The actual stresses, however, are as much as 50 per cent less than those calculated. This strong deviation is probably due to the following causes: (1) Arch No. 1 is provided with a rather strong diagonal wind bracing, which was not taken into account in computing the main stresses. (2) When the zero reading of Arch No. 1 was taken, the tie-rod of the adjacent arch was stressed to 75 per cent of its final value; thus Arch No. 2 influenced Arch No. 1. (3) The sun was shining with variable intensity on one side of the arch. The deviation between recorded and computed stresses was larger in the sun than in the shade.



HYDRAULIC JACKS WERE USED TO STRESS THE TIE-RODS WHILE THE SCAFFOLDING WAS BEING REMOVED

The "Stahl und Eisen" hall was designed by E. M. Hünnebeck, and built by the Dortmunder Union Brückenbau for the Stahlwerks-Verband. The pictures reproduced here are furnished through courtesy of the Beratungsstelle für Stahlverwendung, Düsseldorf-Stahlhof.

TABLE I. OBSERVED AND COMPUTED STRESSES IN ARCH NO. 1

Reading Number	Pressure on Hydraulic Jacks, in Atmospheres		Stress in Tie-Rod No. 1, Lbs	Stress in Lb per Sq In. at Tensometer Number											
	Arch No. 1	Arches Nos. 2 & 3		1	2	3	4	5	6	7	8	9	10	11	12
1 (Initial position)	30	200	33,900	...	...	...	...	...	...	...	...	...	...	...	...
2 (Maximum load)	300	260	339,000	1,510	1,365	1,735	1,650	2,400	970	782	1,350	2,190	3,300	1,000*	1,410*
3 (Tie-rod No. 1 partly relieved)	120	260	134,500	1,140	1,050	1,510	782	1,040	570	3,270	768	710	1,540	8,300*	5,300*
4 (Final load)	300	260	339,000	1,660	1,410	1,620	1,590	2,250	1,095	655	1,123	2,090	3,440	1,070*	7,260*
Computed stress intensity for a tie-rod stress of 280,000 lb				4,950	3,540	2,130	3,540	4,950	4,280	3,540	2,800	3,540	4,280	...	...

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* Tension

Problems of Florida Surveyors

Straightening Out Inaccuracies in Old Surveys and Deeds Calls for Experience and Ingenuity

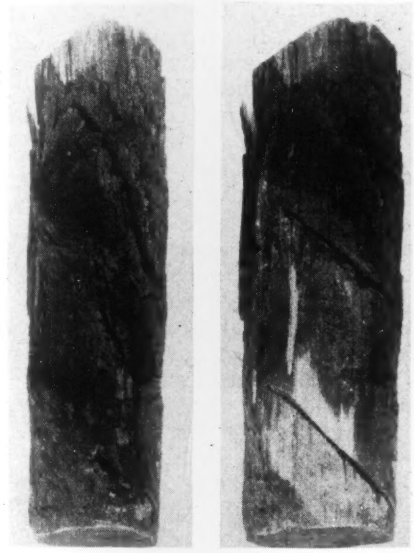
Atoning for the sins of their predecessors is part of the lot of land surveyors everywhere, but the members of the profession in Florida must sometimes feel that they have more than their share of it to do. The indefinite wordings of the old Spanish grants are still causing trouble; errors in the General Land Office survey of the 1830's bear witness to the discouraging conditions under which it was made; and the careless procedure of the early city subdividers is day by day becoming more apparent.

In the first of the following articles, Mr. Gillespie describes a number of specific problems encountered in retracing old land lines. Of special interest is his account of the confusion that resulted when a meander line in a government survey was declared to be "grossly in error." Mr. Wendt, in the second article, tells of the difficulties in adjusting old city surveys to fit present-day lines of occupation, and concludes with some pertinent remarks on the causes of errors in surveys and ways of eliminating them. Both papers were presented before the Surveying and Mapping Division at the Society's Spring Meeting, April 21, 1938.

Retracing Old Land Lines

By Wylie W. Gillespie
Engineer and Surveyor, Tavares, Fla.

Shortly after Florida was ceded to the United States in 1819, deputy surveyors working under the U. S. Surveyor General began its subdivision into the section, township, and range plan known as the U. S. System of Rectangular Surveys. Generally, these surveys were made from 1830 to 1850, although fragmentary and extension surveys have been under way at intervals since that time.



Surveyors Have Something in Common with Detectives

The Ridges on the Dead Pine Tree at the Left Offered a Faint Clue to a 90-Year-Old Survey Line. At the Right, the Outer Covering Has Been Stripped Away, to Confirm the Evidence—Two Ax Cuts, Perfectly Preserved

Since nearly every problem encountered in retracing land lines in Florida today is related more or less directly to the original surveys, we should understand the conditions under which they were made. In 1830, Florida had a population of less than 34,000, which means that much of the state was an unsettled wilderness. The terrain was covered with heavy virgin timber, frequently low and swampy, often impenetrable, and the problem was further complicated by the hostilities of the Seminole War (1835–1842).

A surveyor must visualize these conditions in order to properly approach his problems today. He must also recall that his predecessors were working under instructions issued thirty years before the first "Manual" published by the General Land Office ever left Washington; that they were using the famed "peep-sight compass" and a 100-link surveyor's chain of 66 ft; and that they were getting the munificent pay of from one to four dollars for each mile of line run. We must respect and admire these deputy surveyors and their work. Although we frequently find large discrepancies, in general the United States surveys were remarkably accurate and well executed.

THE BASIC PROBLEMS IN RETRACING A LINE

Retracing of old land lines involves two main problems: (1) reproducing on the ground the physical location of the corners and lines established in the original survey, and (2) retracing sectional subdivision lines and other property lines which in the past have been located from the boundaries marked by the government surveyors. Unfortunately, in most of Florida scant attention has been paid to preserving or remonumenting marks of the original surveys. Consequently one of the most common problems today is relocating the original position of a corner stake placed eighty or a hundred years ago, when the corner itself and all primary contributory evidence of the survey has been destroyed.

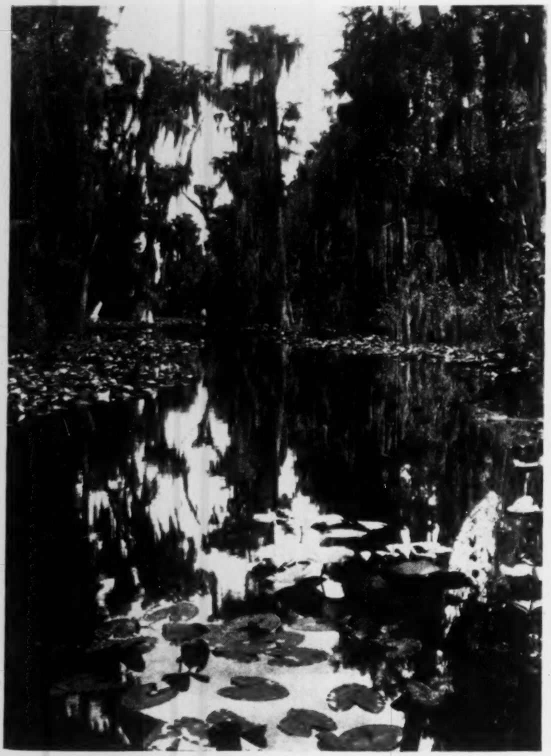
Because of inaccuracies in the original surveys, such a lost corner cannot be reproduced solely by measurement from another positively identified point. Frequently even the systems of single or double proportionate measurement established by the General Land Office cannot be depended upon to arrive at a location that will be held as the true corner at issue.

In a search for a lost or obliterated corner, it is frequently surprising how much evidence a careful examination of the subsoil will disclose to the experienced eye. A section corner established in 1840 was relocated about a year ago in a citrus grove which has been cleared and under cultivation for at least thirty years. The rotted remains of the original wood stake were discovered about 14 in. below the surface of the ground. The burned remains and taproots of the four pine bearing trees described in the field notes were found by excavating to a depth of from 2 to 4 ft. Incidentally, a previous survey had set a stake as marking this section corner about 30 ft from the true position.

The need of ability to look for and recognize evidence that indicates the true position of original lines and corners was aptly expressed by C. H. Eiffert, M. Am. Soc. C.E., in his discussion of the paper by A. H. Holt, M. Am. Soc. C.E., "The Surveyor and His Legal Equipment" (TRANSACTIONS, 1934, Vol. 99, page 1190):

"There are too many young engineers and surveyors who seem to believe that land surveying is merely a matter of turning angles and measuring distances. They are apt to place a tack in a hub with the greatest of precision but, at the same time, overlook or ignore evidences of original corners and boundary lines which, although they may not have been located accurately, are nevertheless the indicators of the true locations of the original lines."

Unfortunately, some older engineers seem to share the misconceptions Mr. Eiffert charges to their juniors. However, the ability to look for and recognize evidences of the original position of these old survey marks can be acquired only by experience.



A NAVIGABLE STREAM THE SURVEYORS MISSED
The Dora Canal, in Lake County, Which Was Omitted from the Original U.S. Meander. The Error Occasioned Considerable Trouble Later

The "Manual of Instructions" previously mentioned establishes a very definite procedure and method to be followed in determining the boundaries of the various subdivisions of a section. However, the land surveyor is frequently called upon to determine the boundaries of properties which, although conveyed as subdivisional parts of a section, have been surveyed and located either by careless or incompetent surveyors or by parties who were ignorant of the approved method of subdividing a section. Many times these old locations have been accepted for years, and properties have been conveyed and reconveyed by descriptions based on them. In such cases, of course, the competent surveyor recognizes that the legal rights of property owners through usage and through occupation and possession must be harmonized with the approved legal method of sectional subdivision. When, as frequently happens, the actual physical boundary of the land conveyed is different from the boundary described by the instrument of conveyance, this circumstance in itself provides a solution of the difficulty.

We must, however, pass over this interesting subject to a consideration of a few specific problems which confront Florida surveyors.

SECTION PLAT AT VARIANCE WITH ORIGINAL SURVEY

The field notes of the United States survey of the south line of a certain Section 6, show that the line was run from the southwest corner east; that the quarter-section corner was established at an even 40 chains; and that the total length to the southeast corner was 84.65 chains. The approved plat of this township, however, indicates clearly that the fractional lots were thrown against the western boundary of the township—and the lands involved were patented according to this official plat. On resurvey, the original corners of the south line were positively identified, and in fact the quarter-section post was located 40 chains east of the southwest corner.

The question of how the section should properly be subdivided was referred to the General Land Office for an opinion. The Land Office, after explaining that it had no jurisdiction in the settlement of disputed boundaries after the lands involved had passed into private ownership, stated as follows:

"The quantity of land patented, therefore, in each case, clearly indicates the intention to follow the subdivision laid down on the plat and not that indicated by the field notes.

"The section should be subdivided by first establishing quarter-section corners on the north and south boundaries 40.00 chains proportionate measurement from the east side of the section, using the quarter-section corners established by the original surveyor, if found, for purposes of alinement only and throwing the fractional measurement against the west boundary, as indicated on the plat; all measurements, of course, to be proportional. The subdivision may then proceed in the usual manner as indicated upon the plat.

"Portions of this land having passed into private ownership many years ago, it may be that certain property lines which are not on the true subdivision-of-section lines have become fixed by adverse possession and cannot now be disturbed."

It happens that certain improved lands in this section do have boundaries which are well established by occupation and possession. An extension of these lines, however, does not determine the boundaries of the adjoining unimproved properties. Their boundaries are determined by the system of subdivision described.

This is a particularly interesting case because it seems to reverse the basic principle that the corners established in the original survey must stand as the true corners they are intended to represent. In this instance, it was the fact that the land had been patented according to the plat rather than the field-note subdivision which determined the ruling just quoted.

TWO OTHER PUZZLING CASES

In another instance, the field notes describe the line dividing Sections 5 and 6 as running from the south-north and intersecting the township line at the mile post set by a previous survey. In retracing this line, the quarter-section corner was found and identified, and in continuing the line north from this corner, the field-note description of the topographic features encountered was found to be correct. However, when this line intersected the township line, it was nearly 800 ft east of the township post.

In this instance the General Land Office, again cautioning that it assumed no jurisdiction in these premises, advised that the corners set on the township line were the only corners of record, and that if they were identified on the ground, they controlled the termini of the subdivisional lines, both for the township to the north and to the south, notwithstanding the fact that they were irrelated by several chains in departure to the subdivision corners in one or both townships. The effect of this was to establish the section line as having a bearing of some 17 deg northwest and locating it in a position on the ground which fails to conform with the distances to topographic features called for in the field notes.

Part of the property affected had been occupied on the ground based on the section line running due north from the quarter-section corner. Some of the property had been conveyed as subdivisional parts of the section, some by metes and bounds descriptions, and some according to the plat of a subdivision made some sixty years ago. The overlaps, discrepancies, and confusion resulting from this condition can well be imagined.

In another instance, a section line intersected a boundary of one of the old Spanish grants, and the intersection corner established in the section line survey overlapped the grant line as marked by a previous survey. The intersection corner was found to be nearly on the line of blazes marked in the grant line survey. A resurvey showed that this blazed line was not straight and that a straight line connecting the grant corners placed the intersection corner inside the grant. In replying to an inquiry about this condition the General Land Office said in part:

"Under ordinary circumstances, it is the practice of this office to treat a section line or other boundary such as described here as a straight line between the established monuments of that line. A blazed line is frequently used as control in the absence of one or more of the original, controlling monuments, but where, as in this case, the full complement of controlling corners is found in place, the blazed line will usually be accepted as corroborative only. Where the blazed line is not consistent with the original corners, it is generally assumed that the blazes were made through error on a random or trial line.

"The corner established . . . at the south end of the line between Secs. 3 and 4 is in the nature of a closing corner which controls the direction of the closing line but not the position of the line closed upon."

MEANDER LINES AS FIXED BOUNDARIES

Another point of interest which perplexes Florida surveyors is the considerable differences frequently found between the location described in the old field notes and the present location as determined by survey, of rivers, lakes, or other natural features which were meandered by the original survey.

The Wekiva River, in Lake County

Meandering This Stream Was One of the Not-Too-Easy Tasks Confronting the Men Who Made the U. S. Survey of 1847

A stream, lake, or other water course is a natural boundary of land. The location of such boundaries is shown on maps of the government survey by a meander line presumed to follow approximately the high-water mark. The fact that the boundary of adjoining lands is the stream or body of water itself and not the meander line, has been well established, and contrary to the belief of some, the meander line is not a fixed boundary and is shown only for the purpose of determining the land and water areas of the property involved. However, it is a well-established legal principle that when the meander line shown by the government survey is fraudulent or grossly in error, this general rule does not apply. Hence upon finding that a certain recorded meander line fails to agree with the actual location of the body of water, we have the problem of determining whether the adjoining lands extend to the water or whether the meander line forms a fixed boundary. In this connection, the General Land Office has stated:

Virgin Growth of Long-Leaf Yellow Pine in Florida

With the Removal of Such Timber, It Becomes Increasingly Difficult to Find the Old Survey Marks

"The courts have held that the power to make and correct surveys of the public lands belongs exclusively to the political department of the government; and the Department of the Interior is the proper tribunal to determine whether lands were, at the date of survey, part of a body of water or were public lands erroneously omitted from survey."

It is also generally accepted that private parties cannot set up a claim that the meander line is a fixed boundary unless the government has asserted title to omitted public lands in front of such meander line after proper showing of fraud or gross error has been made. It follows, therefore, that until the government has asserted such a claim, a surveyor must proceed on the assumption that lands adjoining the meander line actually extend to the water's edge. For the protection of his client, however, the surveyor should carefully report the differences between the recorded meander line and the actual shore line. The government may, at any time, upon proper showing of fact, determine the recorded meander to be fraudulent or grossly in error and proceed to assert title to the lands between such meander and the actual shore line.

A specific instance of such action occurred in the vicinity of a chain of navigable lakes in central Florida. These lakes were meandered in the original government survey and patents were issued to private owners covering the fractional lots adjoining the lakes as shown on the government plat. Later surveyors found that the government meanders did not agree with the actual shore line; however, many hundred parcels of property were conveyed and reconveyed, both before and after that discovery, on the assumption that the fractional lots did extend to the shore line. A considerable portion of the lands involved was subdivided, and is now included within the town sites of three different communities.

In 1926 and 1927, proceeding under an act of Congress, the General Land Office made resurveys and extension surveys of the sections involved, in which the original meander lines were reestablished as fixed boundaries with courses and distances based on the record of the original survey. The extension surveys then meandered the actual shore lines, and plats were prepared of the areas between the original and the new meander lines. More than a thousand acres of land, most of it highly developed, were involved in this resurvey.

This land is shown on dozens of different subdivisions of local record, and the new government maps state that the systems of subdivision shown are perpetuations of those records. Unfortunately, however, the system of subdivision shown on the new government maps is in many instances not a correct perpetuation of the local record. Frequently lot dimensions are shown differently, streets are given a different width, and some streets are shown that apparently existed only in the imagination of the person preparing the map.

These discrepancies are constantly causing difficulty. A surveyor, following the calls of the local record subdivisions will frequently arrive at different corners and boundaries from those he would get if he followed the information shown on the government map. This condition has resulted in much confusion in the preparation of abstracts, in the examination of property titles, and in surveys.

Experience with the case just cited leads the writer to suggest that no good purpose is gained in declaring a meander to be grossly in error or fraudulent. In the case cited the cost to the government of the resurvey and related matters must certainly have been more than the revenue received. The property owners have been put to great expense, have gained nothing, and in many instances find their titles—which were previously thought sound—in an almost hopeless state of confusion.

EACH CASE AN INDIVIDUAL PROBLEM

It is evident from the preceding examples that the retracement of each old land line provides its own separate and distinct survey problem. However, the fundamental principles that have been stressed here should be of benefit in a wide variety of cases.

The manner in which I have treated the problems may lead someone to admonish that a land surveyor should remember he is not a court and has no legal right to set himself up as a judge or jury in property-line disputes. However, the land surveyor should also remember that when he is employed to mark the boundaries of a tract of land, his client expects to take possession of and hold that land. In order to give the client this service, the surveyor must be familiar with, and recognize, those legal principles and rights which affect the location of property boundaries.

Adjusting Old Surveys

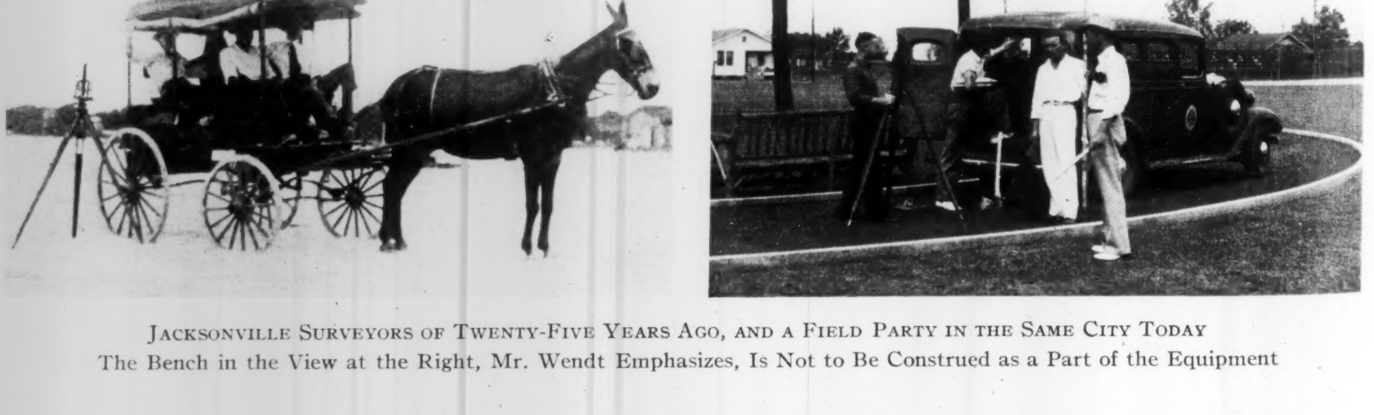
By RALPH E. WENDT

ASSISTANT CITY ENGINEER, JACKSONVILLE, FLA.

AS Florida was under the jurisdiction of several countries before it finally became a part of the United States, its old surveys and property descriptions are probably in as confused a condition as those of any state in the Union. It would hardly be fair, however, to blame the Spanish and British surveyors for all our difficulties. In fact, most of the confusion, so far as city properties are concerned, has had its origin in our own early surveys. The writer's experience has centered in and around Jacksonville, but the conditions described in the following pages are more or less typical of the entire state.

The downtown part of Jacksonville was laid out about 1840 by I. D. Hart. Mr. Hart supposedly made all the lots 105 ft square and all the streets, with a few exceptions, 70 ft wide. His original map, however, shows absolutely no dimensions. It indicates simply that each block contains six or eight square lots of equal size.

Property owners took possession of the various lots and blocks soon after the town was laid out, and started to put up buildings. As the town grew, the old buildings were torn down and more permanent ones built. Finally, in 1901, the business area covered by Hart's map was destroyed by fire. Soon after, the City Engineer De-



JACKSONVILLE SURVEYORS OF TWENTY-FIVE YEARS AGO, AND A FIELD PARTY IN THE SAME CITY TODAY

The Bench in the View at the Right, Mr. Wendt Emphasizes, Is Not to Be Construed as a Part of the Equipment partment started reestablishing street lines. When this work was begun, many irregularities, shortages, and overlaps were found. The rapid pace set by property owners in rebuilding business houses in the destroyed area was more than the small force maintained by the Engineer Department could cope with; consequently many of these irregularities were not adjusted at that time. The Engineer Department, however, found by experience that the only practical way to handle such a matter was to treat each block as a unit. Every endeavor has been made to keep the streets to their supposedly full width of 70 ft, but in many places property owners were found in possession of land which necessitated narrowing the street. The resulting jogs are quite evident today.

In some places blocks that should be only 210 ft north and south have a depth as great as 215 ft; and some that should have a length of 420 ft are as long as 428 ft. These irregularities have caused surveyors, attorneys, and title companies a great deal of worry. A surplus, of course, gives just about as much trouble as a shortage. If a 420-ft block is found to be 428 ft long, where are the interior lot lines?

Some of the local private surveyors have followed the practice of showing proportional lot lines. They make up a map of the entire block and divide it into six or eight lots of equal size according to Hart's old map. They then locate the actual lines of possession in reference to these proportional lot lines, and turn the maps over to the attorneys and title companies, who endeavor to straighten the thing out by having the various owners quit-claim to one another. Attempts are not often made to disturb the actual lines of possession; owners and title companies generally endeavor to make the boundaries according to the paper title fit the boundaries of actual possession.

CARELESS PRACTICES OF EARLY SUBDIVIDERS

Another source of considerable disagreement in Jacksonville is the dividing line between two of the city's subdivisions—Oakland and East Jacksonville, which were surveyed, platted, and recorded in 1868 and 1869. The line, about a mile in length, has been in dispute as long as present-day surveyors can remember. Its two locations, practically coincident at one end, overlap approximately 80 ft at the other. Probably the two original surveyors used different variations at the time the lands were subdivided. Agreements between land owners have settled the difficulty along part of the line, but the remainder has given everybody who has tried to make an adjustment a headache for his efforts. The adjacent properties have for many years been owned by two gentlemen, each claiming title to the land between the two locations of the line and staunchly defending his rights. The case will doubtless be resolved at such time as both parties, or their heirs, sell out to some one person.

Hansontown, another subdivision of Jacksonville, has been a perpetual nuisance because of its irregularly shaped parcels of land. When first laid out in 1880, it was a long way from the center of town, but today it is just on the edge of the city's fast developing downtown section. The original subdividers gave no thought to regular blocks or streets. When a lot was sold, those handling the details would use a measuring stick or rod of some kind, and starting from some fence corner or point agreed upon with the purchaser, would measure off a given number of feet, first this way and then that way, until finally a parcel of land of irregular shape was decided upon as the particular lot in question. Then a deed was made out using a metes and bounds description, and a fence was built by the new owner, adding another page of misery to the book of the local surveyor.

This manner of disposing of the land was continued until the whole tract was finally sold. There is to the present date no regularity of streets, lots, or blocks. The best idea ever advanced as to the proper procedure for making a survey in that area can be credited to the late R. N. Ellis, Jr., a local engineer and surveyor of many years' standing: "Throw a stake as high as you can and wherever it lands, drive it."

The conditions just described will doubtless be corrected at such time as the land values increase enough to make it profitable for some one person or company to secure title to the whole tract and lay off lots, blocks, and streets to conform with the subdivisions surrounding it.

A Laplace Triangulation Station Atop a 16-Story Building in Jacksonville

One of the Key Points in the Coordinate System Survey Now Being Made by the City

Another illustration of the need for survey adjustments is provided by South Jacksonville. Since its annexation by the city in 1932 it has become very apparent that the record plats of some of its subdivisions were improperly drawn and that much careless surveying had been done. For example, one plat recorded in 1886 was drawn without regard to correct angles and lines, and all dimensions to the key lots were missing. As a result, subsequent surveys were made mainly by guess, and as all persons do not guess alike, various occupations became effective. As many as four surveys, made by different surveyors, show variations of as much as 20 ft in one block and 60 ft in another.

This land has now become of such value that the various owners have at times tried to have their lines permanently established, but as the situation now stands no results have been accomplished and a number of suits have been started. It appears that the logical way to settle all arguments would be for all the owners to get together and replat the entire area to fit the occupation —which in this case, fortunately, would hurt no one, as they would practically all have their required areas. However, this is a hard proposition to handle because the majority of the owners are at odds with one another. At present, no likelihood of an adjustment is in sight.

Before 1911 the Engineer Department of the city of Jacksonville had made no topographical surveys of any consequence. Then, for about six years, a large force of engineers and land surveyors was maintained on the making of topographical surveys and platting of maps. Since that time a small number of field parties and office men has been maintained to take care of the growth of the city. Through the work of this department many conflicting surveys and descriptions such as those cited have been ironed out and many necessary adjustments made.

PUTTING TEETH IN THE SURVEYING REGULATIONS

One of the most flagrant causes for the difficulties encountered in the adjustment of old surveys to fit present occupation is the lack of teeth in the old state law governing the filing of plats for record. Many of these plats were inadequately drawn and improperly referenced; in many cases there was just a picture— and in some cases not even a good picture. There was no requirement for showing sufficient angles, measurements, or reference points from which to start an intelligent retracement of an old survey.

This condition existed until 1925. In that year however, as a result of the untiring efforts of leading engineers and land surveyors and their organizations, the legislature passed an act to regulate the making and filing for record of maps and plats. This law requires (1) that a survey shall be made by a civil engineer or competent surveyor who is required to certify on the plat that it is a correct representation of the land platted; (2) that permanent reference monuments shall be placed at intervals of not over 2,000 ft, from which any points may be located (these monuments are required to be of metal, and to be encased in concrete if less than 3 in. in diameter); (3) that the map or plat must show, in the description, the township, range, and section or part of section in which the land is situated, and must contain a sufficient dedication by the owner, with signatures duly witnessed. Finally, the map must bear a certificate of approval by an accredited agent of the county, city, or town having jurisdiction over the land in question.

This law, while perhaps not perfect, is so much better than the old one that those having to deal with municipal engineering departments are pleased that it was enacted. It keeps the "picture plat" off the records, and throws the burden of proof where it belongs with regard to old survey lines.

Another basic cause of errors in many surveys—particularly in city subdivision work—is the surveyor's practice of taking large jobs by contract at low unit prices. Many a surveyor fails to realize that he is not a laborer, but a unit part of a profession—that his duty consists not only in making a living, but in teaching his clients to respect his profession.

There are professional men who will charge the surveyor a hundred dollars or more for a service requiring one or two hours of their time; and who in turn buck like a steer at paying fifteen dollars for the services of a full survey party for a half day. There is, of course, no fault to find with a person for charging a high price for his services. If he is convinced that he is worth the amount he charges, and the position he occupies is so fortified as to warrant his demanding it, then he is entitled to receive it. Moreover, there is no reason to criticize that same person for trying to get his survey done as reasonably as he can. It is only human to barter. If there is any fault to be found it is with the surveyor himself, for not adhering to the same principles as the professional man who has fortified his position and established a prestige that cannot be shaken.

STEPS TOWARD BETTER SURVEYS

The future should see a marked improvement in surveying. Thirty-nine states, among them Florida, now have laws requiring engineers and surveyors to be registered. In Florida many have complied with this requirement, though there are still some who have not. If and when all surveyors comply with this law, further improvements might be secured by developing some sort of classification, whereby each surveyor could be registered to do the particular kind of work he is best fitted to do.

Again, if the much-discussed reciprocal registration were applied to surveyors (and if all states had registration laws), the practice of incompetent surveyors emigrating from one state to another and perpetrating their lack of ability on an unsuspecting public would be eliminated. This would do much to prevent future difficulties in the adjustment of old surveys and descriptions.

FIELD WORK IN CONNECTION WITH THE ESTABLISHMENT OF THE JACKSONVILLE TRIANGULATION NET

Another step towards better surveys is the establishment and legal recognition by each state of some kind of plane coordinate system. Such a system was established a few years ago in Florida by the U. S. Coast and Geodetic Survey, following a request by the Florida Engineering Society in 1933. Monuments to which future surveys can be referenced have been set throughout the state, and an elaborate set of plane-coordinate projection tables, together with directions and formulas for computing the coordinates, has been prepared. Unfortunately, legislative recognition of this system has not yet been secured.

In conclusion, a word of comment is in order on the relation between surveyors and engineers. An ordinary surveyor realizes that he is not capable of designing a bridge or constructing a tunnel; so he naturally devotes his time and energy to the practice of land surveying. On the other hand, a civil engineer from time to time engages in the practice of land surveying—and rightly, for it is part of his equipment as an engineer to be competent to make a survey when the necessity arises.

These are facts which the land surveyor cannot and will not try to ignore. However, his viewpoint should be given consideration. The time is not yet here when all men who are thoroughly competent to retrace the boundary lines of a tract of land have a college degree. Hence not all such men can automatically grasp the new theories advocated along their line of work. If new surveying methods are to be prescribed by law, sufficient time should be allowed for an educational program of considerable magnitude, so that the land surveyor can adjust himself to the new conditions. It is to be hoped that eventually every man who becomes engaged in any branch of surveying or engineering will have had an opportunity to acquire the higher technical training necessary to qualify him to do any part of the work he may undertake.

Treatment of Florida's Artesian and Surface Water Supplies

By Malcolm Pirnie
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Consulting Engineer, New York, N.Y.

Although the Southeast has an abundance of water to meet its constantly increasing demands, the choice of sources and of treatment in any particular case deserves careful consideration. Mr. Pirnie discusses here, with special reference to Florida, the kinds of water available, the important factors to take into account in selecting the source, and the kinds of treatment plants in use in various cities. This paper was on the program of the Sanitary Engineering Division at the 1938 Spring Meeting of the Society at Jacksonville, Fla.

THE southeastern part of the United States should never suffer from an inadequate supply of water. The rainfall is high, and a substantial part of it is held by the very ample groundwater reservoirs. As is typical of nearly all regions in the country, the available supply must be taken from the surface in some localities and from the ground in others.

Southeastern states have been faced with a rising water demand for a good many years. Florida has experienced the greatest tourist trade, and the increased consumption in most cities in the state can be classed primarily as domestic. Recently the influx of industrial plants has increased water consumption tremendously, and in many cases the quality of water needed differs markedly from that of the domestic supplies. The effect of a new industrial plant on the water supply of a community is more pronounced than a growth in population. Although the increase in size of many resort cities has been phenomenal, a single paper mill may require almost overnight as much water as a city of 100,000 people or more. For this reason, it is vitally important that careful consideration be given to the effect of such an increase in draft.

Requirements of domestic and industrial supplies frequently vary to a large degree. These have been covered in detail many times, and need not be discussed here. Since the quality of waters varies substantially from place to place, the treatment is a specific problem for a given locality. This is especially true in the case of industrial supplies, where the importance of the several water characteristics depends wholly on the particular purpose for which the supply is intended.

The quality of the water available in the Southeast covers a wide range. Figure 1 indicates the mineral content of waters used in several cities of Florida and other states. The graphs have been plotted from calculations based on U. S. Geological Survey data. The vertical scale is milligram equivalents, and the high graphs indicate waters with large mineral contents. Thus, Sarasota, with a total dissolved solids content of over 1,000 ppm, has the highest graph, and the Edisto River, supplying Charleston, S.C., the lowest. The silica content is indicated below the base line, since this does not enter into the balance between positive and negative elements. Following the procedure suggested by W. D. Collins, of the U. S. Geological Survey, an equivalent weight of 30 is assumed for silica.

The Tampa analysis represents a water of average hardness, but it should not be assumed that this average condition prevails generally throughout the year. The Hillsborough River is exceedingly variable in quality; during the rainy season it is highly colored and soft; during the dry season most of the supply comes from ground-water discharge, and is hard. Orlando and West Palm Beach use lake waters that are soft and highly colored. The Edisto River, which supplies the new paper mill at Charleston, is exceedingly soft and has a high color. It is almost universally true that the surface waters in the southeastern states are soft and either highly colored or very turbid, especially after heavy rains bring discharges from the swampy areas of the coastal plain or wash from the Piedmont Plateau. Such rivers as the Savannah and Santee are characterized by high turbidity, while the St. Marys and Edisto rivers are relatively free from turbidity although highly colored.

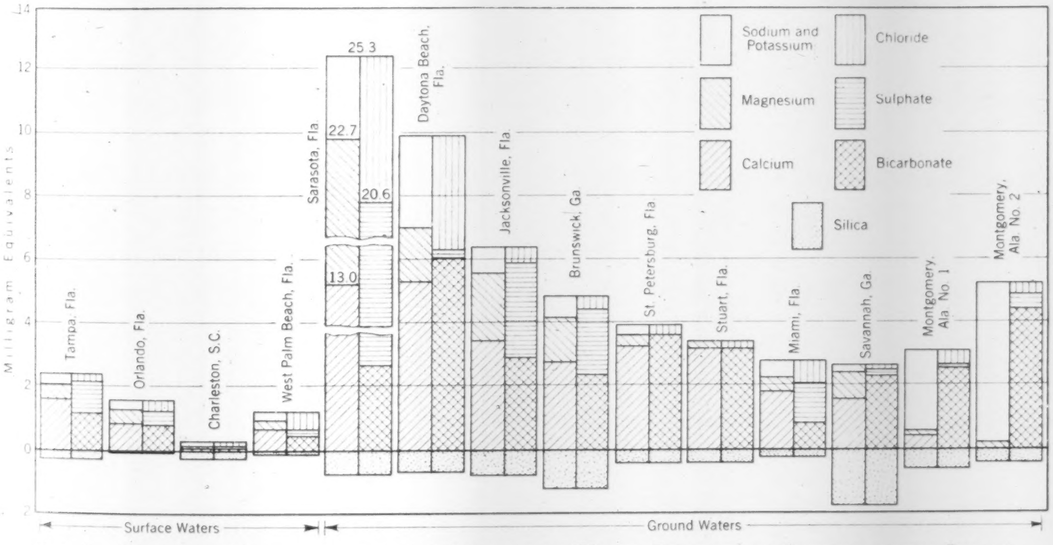
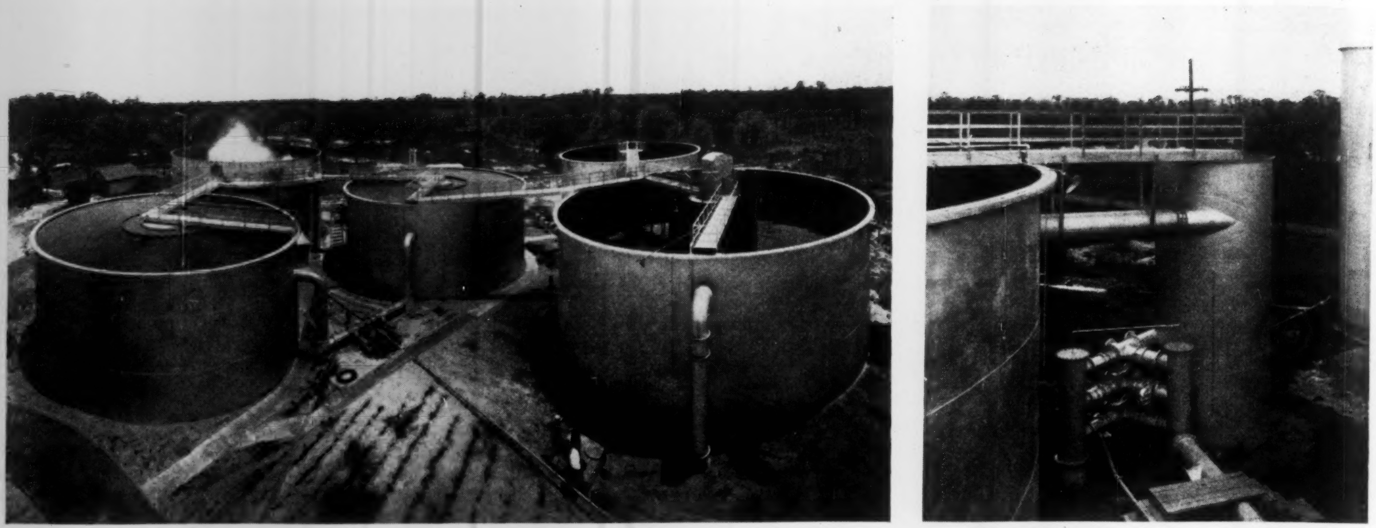


Fig. 1. **Mineral Content of Typical Municipal Water Supplies in Southeastern States**

Outstanding in the analyses of groundwater supplies shown graphically (Fig. 1) is the high sulfate content of the water from the Ocala at Sarasota. This has required extensive softening operations, which are described later. The Daytona Beach, St. Petersburg, and Savannah analyses are typical of low sulfate waters from the Ocala; the Jacksonville and Brunswick waters are fairly high in sulfates. Mi-



The "Split-Treatment" Plant at St. Petersburg Includes Aeration, Softening, Coagulation, and Filtration
The Close-Up at the Right Shows the Tank in Which Softened and Ferric-Sulfate Treated Waters Are Mixed Prior to Coagulation

ami, Fort Lauderdale, Hollywood, and Stuart obtain their water from shallow wells driven into water-bearing strata "perched" above the Ocala formation. The Stuart water contains 4.5 ppm of iron and is typical of many relatively small "perched" ground-water supplies. The shallow wells at Montgomery, Ala., and the deep wells in the vicinity of Charleston, yield water high in sodium.

In a general way Fig. 1 indicates the kinds of water available for domestic and industrial use. The principal limiting factor in the increased use of surface waters is the quantity available. In the use of ground waters, the principal limiting factor is chemical rather than quantitative. It is true that the quantity of ground water that can be withdrawn at any location is limited by the resulting drawdown in ground-water head required to cause this quantity to flow to the wells. Excessive drawdown is objectionable because a reduction in ground-water head by one group of wells reduces the discharge of all other wells in the immediate area and will frequently necessitate pumping where the benefits of artesian flow were formerly enjoyed. But the real danger in excessive drawdown lies in the possibility of salt-water intrusion and increase in sulfate content. This same danger may arise from wells driven too deeply so that salt water in a lower stratum can escape into fresh-water strata above. The possibility of salting the existing supplies is the real menace to be watched as consumption increases in any area. This is particularly important when a large draft, such as required by an industrial plant, is imposed upon the water-bearing strata in a restricted area, for here little warning will be given of the ultimate consequences.

Before taking up the discussion of how the available waters can be treated to make them suitable for use, some mention should be made of the selection of the water source, from a chemical viewpoint. From studies made in connection with the Florida Canal, the various intake and discharge areas of the Ocala limestone have been fairly well established, as shown in Fig. 2. By plotting the numerous wells for which mineral analyses are available, it has been possible to estimate the chemical qualities to be expected within given areas. Figure 3 shows the general variation in sulfate content of Ocala rock ground waters throughout the Florida peninsula, and it will be noted that the areas of low ground-water movement (that is, stagnant areas), and discharge courses from such areas, contain water with high sulfates. Areas where there is free flow of ground water from intake to discharge yield waters of low sulfate content. Certain cities are so located that they can reach such water without excessive expense. When the cost of softening a high-sulfate water, or the expense of using it unsoftened, is considered, it is not difficult to justify a fairly long pipe line. The low-sulfate water near Cosme, in Hillsborough County, is now carried 26 miles to St. Petersburg. Excellent water immediately west of the city is available

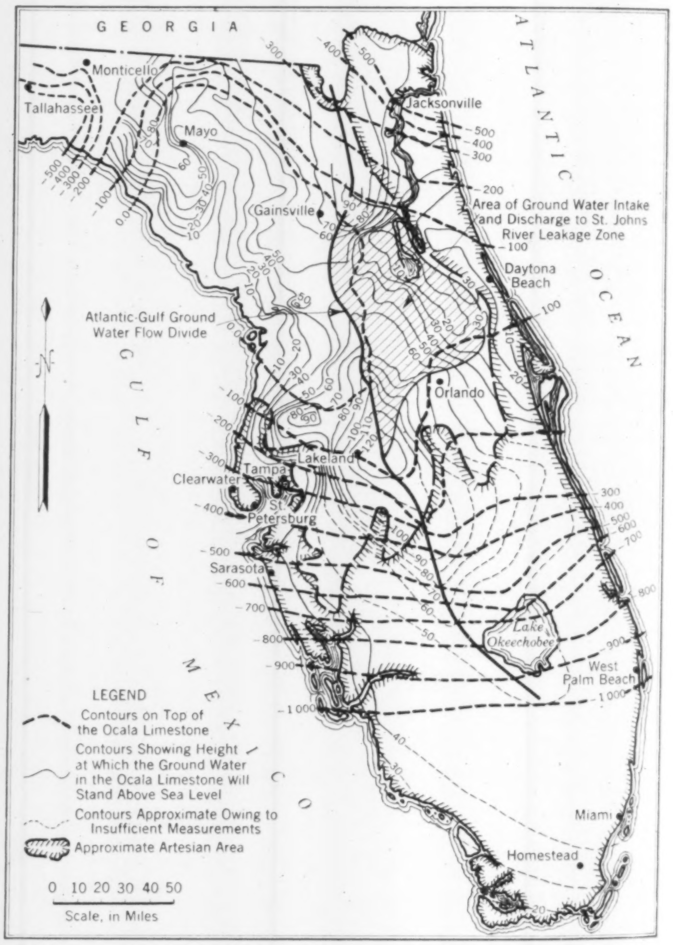

GEORGIA
ATLANTIC OCEAN
GULF OF MEXICO
Monticello
Tallahassee
Mayo
Jacksonville
Gainsville
Area of Ground Water Intake and Discharge to St. Johns River Leakage Zone
Daytona Beach
Atlantic-Gulf Ground Water Flow Divide
Orlando
Lakeland
Tampa
Clearwater
St. Petersburg
Sarasota
Lake Okeechobee
West Palm Beach
Miami
Homestead
N
LEGEND
Contours on Top of the Ocala Limestone
Contours Showing Height at Which the Ground Water in the Ocala Limestone Will Stand Above Sea Level
Contours Approximate Owing to Insufficient Measurements
Approximate Artesian Area
0 10 20 30 40 50
Scale, in Miles

Fig. 2. Piezometric Contours and Structure Contours on Ocala Limestone; Approximate Artesian and Intake Areas; and Divides Between Various Areas of Ground-Water Flow

for the needs of Daytona Beach for many years to come. Consumption at Jacksonville has produced a deep depression cone, and the water contains well over 100 ppm of sulfates. However, Jacksonville can obtain an adequate supply of water low in sulfates which can be delivered as an excellent soft water at a very moderate cost.

It is, of course, not always economical to go to distant sources for water, but in developing additional supplies, a complete study should be made of all waters in the region. Extending a pipe line a few miles in another direction may yield a much better water.

VARIOUS TYPES OF TREATMENT PLANTS IN USE

The wide range of water characteristics naturally requires numerous types of treatment plants and procedures. The following paragraphs will outline briefly the actual practice in a few cities.

The treatment at Tampa varies with the seasons. During the rainy periods only color removal is necessary but in the dry months softening must be added. The raw-water color varies from 200 to 25 ppm, and total hardness from 25 to 200 ppm. The water is coagulated with alum before going to rapid sand filters. Any softening required is accomplished with lime, and recarbonation with CO_2 gas precedes filtration.

The recent construction of pulp and paper mills in Florida and neighboring states has caused a large increase in the demand for water. While many of the wells are using ground water, some of the soft surface waters are available for further development.

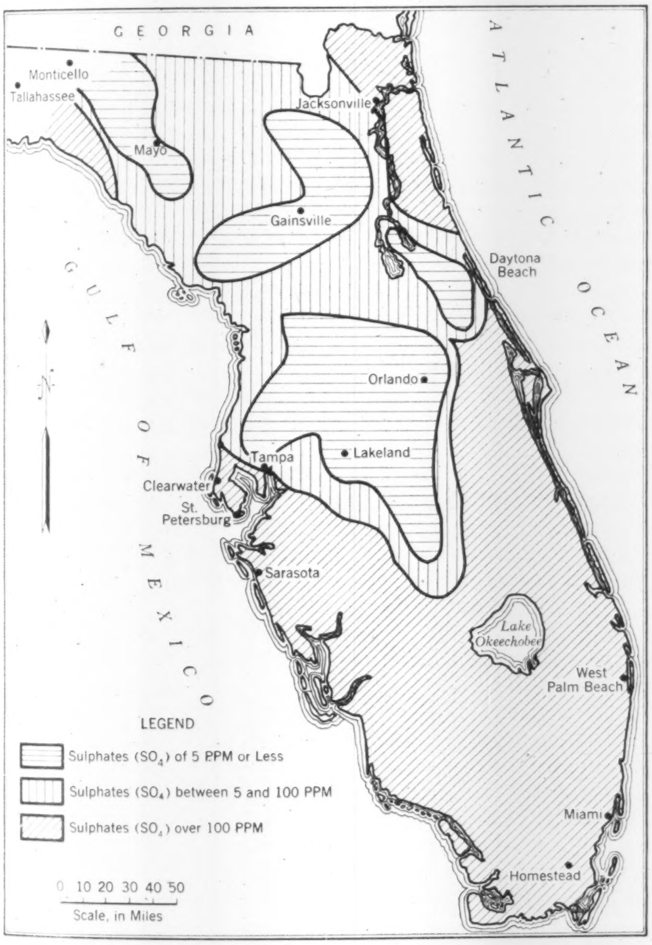
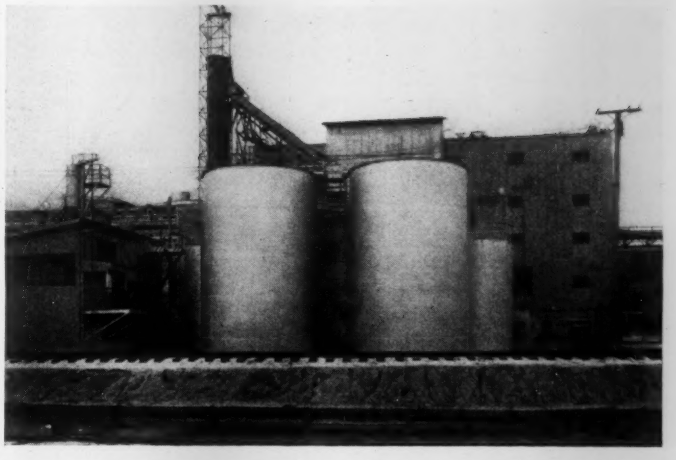


Fig. 3. Approximate Areas of Low, Moderate, and High Sulfate Content in the Ocala Rock Ground-Water Reservoir



The Boiler Feedwater Treatment Plant of the West Virginia Pulp and Paper Company at Charleston, S.C.

The West Virginia Pulp and Paper Company plant at Charleston uses the very soft, colored water of the Edisto River for all process work and boiler feedwater. The high steam demand for process work requires considerable make-up water for the boilers, and all the boiler feedwater is thoroughly treated. Since the product of the mill is unbleached kraft, the process water is only screened. Anhydrous ferric sulfate, used as the coagulant, has been effective in reducing the color of the filtered water from 200 to 5 ppm. In addition it has reduced the silica considerably. Since silica is a very objectionable scale former, any decrease is desirable. The coagulation tank is of the upward-flow type, so that the dosed water passes upward through the ferric hydroxide floc that previously has settled out. The sulfates needed are supplied in the coagulant and the small proportion in the form of calcium sulfate is later converted to sodium sulfate in the zeolite treatment of the filtered water, which also unavoidably adds some sodium chloride. The final water is further conditioned for high-pressure steam boilers.

West Palm Beach and Palm Beach use surface water collected in a system of canals and stored in two shallow lakes. The raw water has a color varying from 50 to 200 ppm and averaging about 95 ppm. The annual average alkalinity runs from 18 to 26 ppm, and the hardness from 27 to 33 ppm. The annual average alum dose is from 2.9 to 3.3 grains per gal, and is followed by aeration before the water goes to the coagulating basins. Hard well water is added to the raw water after dosing, and this adjusts the pH to give best coagulation. The amount of well water averages 5 per cent of the raw water but is varied to correspond to the alum dose and to maintain the optimum pH. During the rainy season, when the raw water is high in color and low in alkalinity, larger doses of alum and more well water are used. Contact between the alum floc and the dosed water entering the coagulation basin is obtained by vertical circulation of water in the first bays of each basin. The settled water is filtered, and may be aerated on the way to the clear well. About 0.7 to 0.9 grain per gal of lime is added to the filtered water to raise the pH to 9.5 and render the treated water non-corrosive.

Treatment of well waters usually involves aeration for removal of CO_2 and H_2S if present, softening, and filtration, although many well waters are used with no treatment. A few "perched" ground-water sources containing considerable iron and little organic matter may be converted into satisfactory domestic supplies by a simple process for iron removal.

The kind of softening process can be determined properly only if the character of the water and its use are definitely kept in mind. If sulfates and chlorides are not high, lime treatment alone will suffice for domestic requirements. Where sulfate and chloride removal is desired, the lime-soda or base-exchange processes may be used. The cold lime-soda treatment used in municipal supplies should not be confused with the hot lime-soda process for boiler-water conditioning. The hot process permits a much shorter settling time and yields a softer water, but it naturally has no place for general domestic or large industrial supplies except where hot water is called for by the process.

LIKE MANY OTHER CITIES, WEST PALM BEACH HAS TAKEN PAINS TO MAKE ITS WATER WORKS ATTRACTIVE AS WELL AS EFFICIENT

SOFTENING AND FILTRATION PLANTS

There are several softening and filtration plants operating in Florida, and a few remarks about these will indicate the methods used.

Sarasota has a 1.0 mgd zeolite softening plant that was completed early in 1937. The well water used by the city is exceedingly hard (over 1,100 ppm as $CaCO_3$), and the sulfates and chlorides total over 1,000 ppm. The chemical cost for either lime-soda treatment or zeolite with salt-brine regeneration would be excessive. Sea water is used to regenerate the zeolite, and the only chemical cost is chlorine. For every million gallons of softened water produced, 400,000 gal of sea water are pumped to the plant, coagulated, filtered, and chlorinated. The plant is fully automatic and produces a water in which sodium salts have replaced the salts of calcium and magnesium with a hardness reduced to 100 ppm, at an estimated operating cost of $14 per million gal.

The Pinellas Water Company supplies the city of St. Petersburg with 5.0 mgd of water softened and filtered in a split-treatment plant completed in 1936. Hardness is reduced from 185 to 100 ppm as $CaCO_3$. Sixty per cent of the raw water is aerated and softened with lime. The lime softening tanks are of the upward-flow type, and the dosed water passes through the lime sludge after it is discharged from the orifices in a radial pipe system at the bottom of the tank. Forty per cent of the raw water is treated with ferric sulfate mixed violently with the clear effluent from the softening tanks and delivered to an upward-flow coagulation tank. The ferric sulfate, in reacting with the bicarbonates of the raw water and the hydroxide of the softened water, forms an excellent floc. All the water is then filtered. No recarbonation has been necessary to date, because the CO_2 present in the 40 per cent of the well water which is not aerated, and the half-bound carbonates released by the addition of ferric sulfate, are available when the softened and raw waters are brought together in the mixing tank just preceding coagulation.

The Oolite limestone at Miami yields a water with a hardness of nearly 300 ppm (of which 45 ppm is non-carbonate), and a color that varies from 20 to 60 ppm. The water is treated with lime and a small amount of alum to accelerate precipitation. Following the chemical treatment, the water is aerated, mixed, clarified, recarbonated with CO_2 gas, and passed through rapid sand filters. The final water has a total hardness of 90 ppm, and practically zero color and turbidity.

At Daytona Beach, the water is slightly harder, but the treatment is almost the same as that at Miami. Soda-ash is added to take care of the non-carbonate hardness. One of the two plants at Daytona is of the "fill-and-draw" or intermittent type; the other is continuous.

The iron-removal plant for Stuart, and at least five other similar plants in Florida, are effectively removing iron from ground waters which contain iron in amounts varying from 5 to 20 ppm. The water is first aerated, the extent of aeration depending upon the hardness of the water. Medium hard waters are only slightly aerated; very soft waters are completely aerated by means of a fine spray. The water is then passed upward through a 9-ft bed of graded gravel at the rate of 2 gal per sq ft per min. The clear water from the top of the beds is aerated to discharge free CO_2 released by the breakdown of the ferrous carbonate and is then suitable for domestic uses. Opening a waste valve on the underdrains about once a week, and applying a 4-ft per min upwash to the bed about once a month, removes the iron accumulations and keeps the beds in proper condition. Cost of treatment is limited to pumping cost for head lost in aeration and in the beds and for about 1 per cent of the water wasted in washing.

Many other plants, some similar and some vastly different, could be cited, but the few examples given indicate the variety of conditions to be met and how some of them have been handled.

As stated earlier, it is not possible to go into all the requirements for special industrial processes. However, some mention should be made of a relatively new zeolite used for the reduction of sodium bicarbonate. Instead of the usual salt regeneration, acid is used, and hydrogen is the base of the zeolite. After treatment, pH adjustment is necessary and is accomplished by the addition of some form of alkalinity. While the use of this process is necessarily limited, it should find applications where even moderately high sodium content is objectionable. It will probably be more attractive further west, but may be used for such waters as are found at Montgomery.

Separate industrial supplies are quite common where a single plant is large enough to have its own supply. Birmingham, Ala., has recently gone one step further, and has provided a large independent soft-water supply for the numerous industries located in the city. The pH is adjusted at all times to reduce corrosion, and the supply is super-chlorinated. Super-chlorination renders the water harmless, makes it taste exceedingly unpleasant, and prevents the growth of slime in pipes and equipment. Prevention of slime in condensers is necessary for economical operation, and the savings will pay for the chlorination in a short time.

The subject of this paper is far too broad to permit complete treatment. It is hoped that the discussion will bring out more details and specific information regarding particular plants in the region.

Sixteen Years of Flood Control in the Miami Valley

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and C. S. BENNETT, M. AM. SOC. C.E.
RESPECTIVELY CHIEF ENGINEER AND ENGINEER, THE MIAMI CONSERVANCY DISTRICT, DAYTON, OHIO

In any study of flood regulation, all trails lead sooner or later to the Miami Valley, where the pioneer large-scale detention-basin flood-control project was completed in 1922. With the current interest in flood control it is worth while to review briefly the principal features of that project, and then examine its record of operation over the past 16 years. The present article is a composite abstract, brought up to date, of two papers that were presented at the Ninth District Convention of the Society at Dayton, Ohio, in October 1937.

THE Miami Valley had been intermittently ravaged by floods from the time of its settlement—prior to 1800—but it was not until after the great disaster of 1913 that any concerted, adequate attempt was made to provide protection. In that year, water ran 12 ft deep through the principal streets of Dayton and other valley cities. More than 400 lives were lost and property damage exceeded $100,000,000. Hundreds of acres of fertile farm land were washed away or so covered with sand and gravel as to make them permanently useless for agriculture. Before the wreckage had been cleared from the streets, plans to prevent a recurrence of disaster were under way. Relief committees were organized and a large fund was raised by public subscription so that studies of the problem could be started at once.

At first several communities started independent investigations, but it was soon realized that in order to secure an economically justifiable and feasible system of flood control, it was essential for them to act as a unit. To make such an undertaking possible, the Conservancy Act of Ohio was passed in February 1914. This law permitted the organization of conservancy districts as political subdivisions, with taxation and other necessary powers. A board of directors, consisting of three prominent business men of the valley, was appointed under the law by the Conservancy Court, and employed the organization necessary to carry out the work of the Miami Conservancy District. Up to the present time this organization has been entirely non-political.

The engineering organization of the District made a thorough study of Miami floods. It surveyed and mapped the valley and investigated all the periods of excessive precipitation in the eastern half of the United States of which there was any record. These studies constituted the fundamental data on which the plan of protection was based.

The official plan, as finally adopted, consists of five retarding basins, supplemented by channel improvements or levees in eight cities (Fig. 1). The system is designed to handle, without using the spillways, a flood 40 per cent greater than that of 1913—and such a flood is 15 or 20 per cent in excess of what is believed to be the greatest possible flood in the valley.

The ordinary flow of the streams passes unobstructed through the conduits in the dams. There are no gates or manual controls of any kind. During a flood the water rises automatically behind the dams, is held temporarily, and drains off gradually. The channels through the cities are designed to carry the combined maximum discharges from the dams with a freeboard on the levees of approximately 3 ft.

Construction work was carried out from 1918 to 1922 at a cost of approximately $30,000,000. As this work was started in the days when people were still paying for what they got, the cost was assessed against benefited real property and benefited communities in proportion to the benefits. The measure of benefits to real estate was based on the depth of flooding in 1913. Property not flooded was as a rule not considered directly benefited, while that flooded 10 ft or more deep was considered benefited the maximum amount, or 100 per cent. Various percentages of benefit were worked out between these extremes. The property was given appraised valuations with and without flood protection, the difference between the two being the estimated value of protection. This difference multiplied by the benefit factor gave the benefit in dollars and cents for any piece of property. The actual assessment amounted to 50 per cent of the benefit. The cash required was realized from the sale of bonds, which mature over a period of 30 years in such a way that annual payments are about constant. At the end of 1937, about 63.5 per cent of the total amount required for principal and interest had been paid.

OPERATIONS SINCE COMPLETION OF SYSTEM

A project such as that of the Miami Conservancy District cannot be tested at will. Hence it is necessary to exercise constant vigilance in order to keep the improvements in condition so that an emergency can be met at any time. In addition the District is continuously collecting data on rainfall and runoff and their relations. Rainfall and river gages are maintained in cooperation with the U. S. Weather Bureau and the U. S. Geological Survey; accurate discharge measurements are made

THE LAND WITHIN THE RESERVOIRS DOES NOT LIE IDLE
In Fact, in This View of the Taylorsville Dam, One May Have to Look Twice to Determine Which Is the Upstream Side

CHANNEL IMPROVEMENTS AT DAYTON AND OTHER CITIES WERE AN INTEGRAL PART OF THE FLOOD CONTROL PROJECT

The River Here Is Discharging 40,000 Cu Ft per Sec. With a Flow Three Times as Great, the Levee Freeboard Would Still Be 3 Ft

during all floods; studies of all excessive precipitation in the eastern half of the United States are kept up to date; and coefficients of friction are calculated for conduits and channels to check them against the design.

Conduits were designed with an assumed value for Kutter's *n* of 0.013. Actual computations made from accurate discharge measurements show this coefficient to be about 0.011. This gives the conduits a slightly greater discharge capacity than the design called for. (It was known at the time, of course, that 0.013 was somewhat high for smooth concrete, but it was assumed that the interiors of the conduits would roughen with age.) The coefficient of roughness for the improved channels varies from approximately 0.020 to 0.030 and also averages somewhat less than that used in the design.

It is now 16 years since the works of the District became effective in reducing floods. One way of judging this effectiveness is by the number of times that water has been stored above the dams, for whenever there is storage there must be a corresponding reduction of peaks below them. The records show that there has been such storage 90 times at Germantown, 62 times at Lockington, 75 times at Englewood, 22 times at Taylorsville, and 25 times at Huffman.

The system functioned first in April 1922 (actually before its completion), when a heavy rainfall on saturated ground caused water to be stored back of all dams. The river stage at Dayton was slightly less than 10 ft, whereas under former conditions the old danger mark of 18 ft would have been exceeded and a considerable flood scare would have resulted. Everything worked out according to plan. The water was carried through the improved channels in the cities smoothly and swiftly, the turbulent appearance of former floods being absent.

Other important floods occurred in June 1924, February 1929, May 1933, and January 1937. The greatest of these was the one of January 1937, which resulted in a peak of 14.6 ft at Dayton and 16.5 ft at Hamilton. There was backwater at all the dams, varying in depth from 24 ft at Huffman to 55 ft at Englewood.

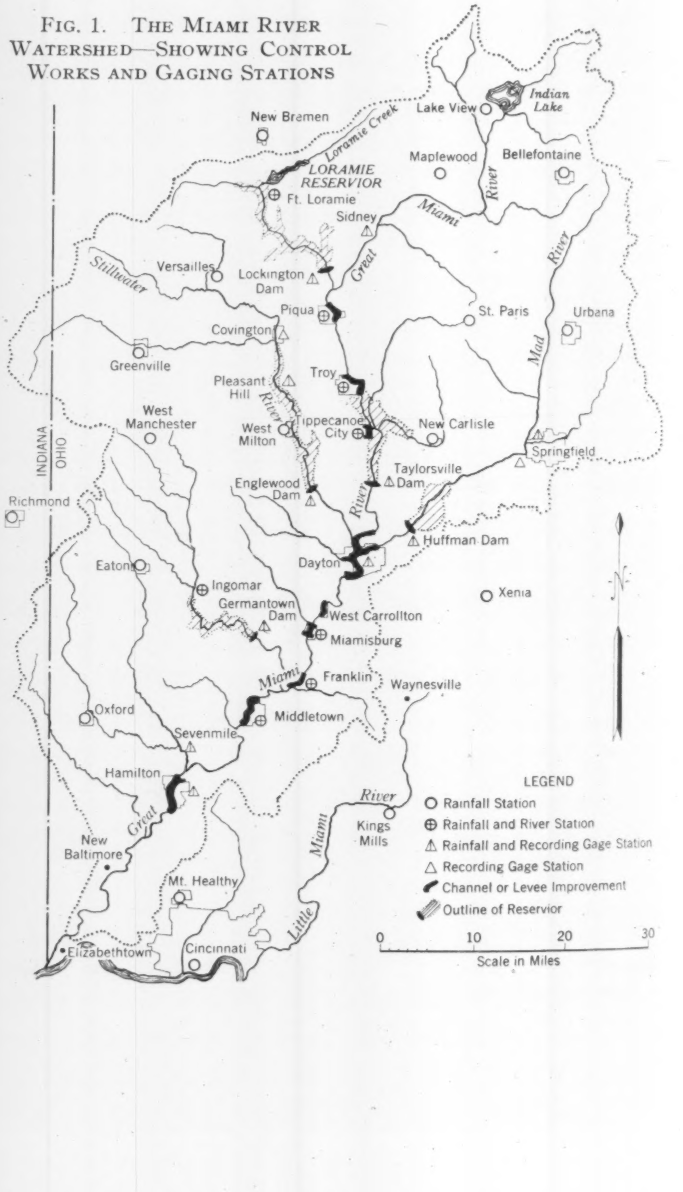
The question has been asked many times if we would have had a repetition of the 1913 flood in January 1937 had the protection works not been in existence. The answer is "No." However, without the improvements, no doubt hundreds of families would have been compelled to move out of the low-lying sections. Actually the population remained calm and there was no damage to property in the protected areas.

While the operation of the retarding dams is entirely automatic and it is known that controlled discharges through the cities in the District will not endanger the levee systems, there is considerable demand for information regarding expected peak stages following major storms. In order to furnish this information, as well as to advise land owners in rural areas who are not fully protected by levee systems, regarding impending rises, a method of forecasting the time and amount of peak stages resulting from heavy rains has been developed.

The method has been derived from an analysis of 41 storms during the period from 1924 to 1937; recent developments in the application of the "unit hydrograph" theory are involved.

Data for 26 storms developed the fact that the time interval from the hour at the mid-point of the rainfall period to the hour of peak stage at Dayton varied from 28 to 44 hours, but 90 per cent of these intervals were between 28 and 35 hours, with a mean interval of 32.4 hours. The variations in length of these intervals appear to be irrespective of season or amount of precipitation, so long as the precipitation is continuous and does not extend over more than about 48 hours. It is possible, therefore, to predict the time of the crest stage at Dayton within close limits as soon as the rainfall data are available—and observers at all the rainfall stations report by telephone to the Dayton office whenever the rainfall exceeds 1 in. in 24 hours.

FIG. 1. THE MIAMI RIVER WATERSHED—SHOWING CONTROL WORKS AND GAGING STATIONS


Indian Lake
Lake View
New Bremen
Loramie Creek
LORAMIE RESERVIOR
Ft. Loramie
Maplewood
Bellefontaine
River
Miami
Sidney
Great
River
Stillwater
Versailles
Lockington Dam
Piqua
St. Paris
Urbana
Covington
Greenville
Mad
Troy
Pleasant Hill
River
West Manchester
West Milton
Tippecanoe City
New Carlisle
Springfield
INDIANA
OHIO
Taylorsville Dam
Englewood Dam
River
Richmond
Huffman Dam
Dayton
Eaton
Ingomar
Xenia
N
Germantown Dam
West Carrollton
Miamisburg
Miami
Franklin
Waynesville
Oxford
Middletown
Sevenmile
Hamilton
River
Great
Kings Mills
Miami
New Baltimore
Mt. Healthy
Little
Elizabethtown
Cincinnati
LEGEND
○ Rainfall Station
⊕ Rainfall and River Station
△ Rainfall and Recording Gage Station
△ Recording Gage Station
Channel or Levee Improvement
Outline of Reservior
0
10
20
30
Scale in Miles

In order to determine a means of estimating quickly the probable magnitude of the crest stage at Dayton, a more detailed study of the storms was made. This included the tabulation of precipitation data and general weather conditions for various periods up to one month preceding each storm. The storms were segregated into seasonal periods, as it was recognized that certain characteristics of precipitation and runoff are seasonal. Four periods were adopted, to fit climatic conditions common to this section of the country, and for each the total runoff in inches at Dayton for each storm was plotted against maximum resulting gage height at the same point. It was discovered that there is a definite relation between these two factors, as would be expected from a consideration of the "unit hydrograph" theory. Smooth curves were drawn to fit the points on the four graphs. Thus it appeared possible to estimate closely the crest stages at Dayton if the total runoff for a storm was available.

The problem then was to devise a means of estimating total runoff from the total precipitation data secured for each storm, keeping in mind that the process must be simplified as much as possible. Analysis of weather and ground conditions preceding and during each storm indicated the possibility of assigning runoff factors or percentages for various types of conditions, these factors to be applied as multipliers of the total storm rainfall. In order to simplify the process, the types of conditions were restricted to five, and factors were assigned for each of the four seasons in these five groupings.

These factors are given in Table I. Their wide variation shows clearly the futility of trying to estimate total runoff without some kind of guide. While the guide herein developed is, of course, merely a refined approximation, it gives reasonably reliable and close results when applied with judgment and a knowledge of conditions precedent to and during a storm. In 11 tests of the method, the estimated total runoff was within 10 per cent of the actual amount in 10 cases.

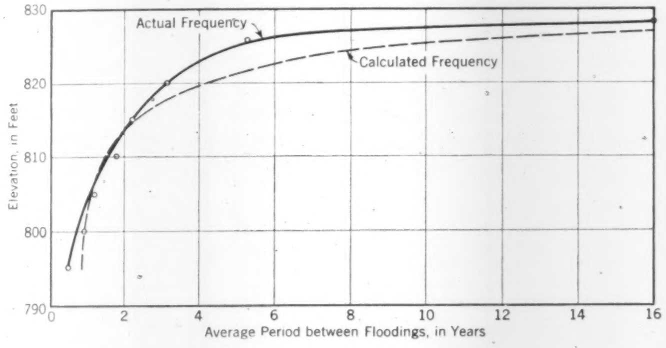


Fig. 2. Frequency of Flooding to Various Elevations in the Basin Area (Englewood Reservoir)

When storm periods follow each other closely, so that the runoff from the second storm appears before that from the first has passed, the estimation of succeeding peaks is more complicated. Each storm period must be treated separately. In such cases, a discharge graph is plotted from hour to hour as gage readings are received. It is usually possible to estimate from the slope of this graph, on the falling stage after the first peak, the amount of runoff due to the first storm. Then an estimate can be made for the second peak stage by the usual procedure.

FREQUENCY OF FLOODING IN RETARDING BASINS

Another matter of interest to citizens in the District, especially to operators of farm lands in the retarding basins, is the relative frequency of flooding on the areas available for cultivation. (All the lands in these basins are used for agricultural purposes, except some areas immediately upstream from the dams. Restrictions on the location of buildings within the areas subject to backwater flooding remove any hazard to life or property.)

The Hydraulic Jump in Action at Germantown Dam
Water Leaving the Conduits at 44 Ft per Sec Flows from the Stilling Pool at 8 Ft per Sec

Frequency studies were made prior to the erection of the dams by routing past floods through the basins. "Frequency of flooding" curves were prepared from these data, and are used for scheduling farming operations as well as for other purposes. In the 16 years since the completion of the works, flooding frequencies have closely followed the calculated data, as shown by the diagram for the Englewood Reservoir, Fig. 2.

It was found desirable also to investigate frequency of backwater flooding from the standpoint of seasonal effect. Had the dams been in operation since 1893, a total of 60 floodings affecting farm lands would have occurred to date in the Englewood basin. Of these, 43 would have taken place in the first four months of the year. On only four occasions would there have been flooding during the growing period (June to October).

Table I. Ratio of Total Runoff at Dayton to Total Average Rainfall Above Dayton, in Per Cent

Conditions	Winter Dec.-Mar.	Spring Apr.-June	Summer July-Sept.	Fall Oct.-Nov.
Snow and ice, frozen ground, followed by rain and thaw .	100+	80–90	. . .	. . .
Wet ground, heavy preceding precipitation, thaw after cold weather	60–75	70–80	30–40	45–60
Moderately wet, some preceding precipitation	50–60	50–70	20–30	30–45
Moderately dry, little preceding precipitation	35–50	25–45	10–15	20–30
Very dry	30–35	5–20	1–5	5–20

Another question that often arises is the effect of the controlled Miami discharge on Ohio River floods. After several recent floods, reports were current that the Miami improvements had greatly increased the depth of flooding in the Ohio at Cincinnati. Now the mouth of the Miami is located some twenty miles downstream from Cincinnati. During the peak of the January 1937 flood in the Ohio, the fall in this distance was approximately 8 ft; and at that time Ohio backwater extended up the Miami for about 10 miles. Obviously the effect of the Miami on the water level at Cincinnati must be negligible.

The effect of the controlled Miami further downstream on the Ohio may be either adverse or favorable, depending on the timing of the peaks in the two streams, but in any case it is slight. By the time the mouth of the Ohio is reached it is almost entirely lost.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Picture Presentation of Membrane Analogy for Design in Torque

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IN the Engineering Societies' Monograph, "Theory of Elasticity," by S. P. Timoshenko, Chapter 9, a method for computing the resisting moment in torque for non-circular forms is outlined. For a mathematical presentation of the method, this reference should suffice. It is here intended to give a picture presentation of the method in its application, showing how results can be estimated, or how the engineer can more safely sense a reasonable approximation.

The equipment as used in the laboratory need be described no further than to say that a soap film is spread over a hole in a thin plate and slightly inflated. The hole is the exact shape of the cross-section of the bar subject to torque. The derivation shows that the slope of the inflated film at any point is nearly proportional to the shear stress, S, at that point; and the volume enclosed by the film is proportional to the resisting torque, M_t, carried by the bar.

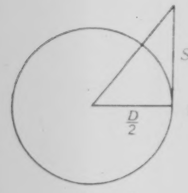


FIG. 1

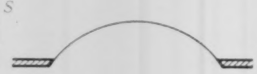


FIG. 2

First, consider a round bar which may be checked analytically. Let Fig. 1 represent a section of the shaft subject to torque and having a shear stress S at the surface. Then $S = \frac{M_t D}{2I_p}$ or $M_t = \frac{2SI_p}{D}$ in which M_t is the torque; D, the diameter; and I_p the polar moment of inertia.

Now let Fig. 2 represent a slightly inflated soap film having its maximum slope at the outer edge and no slope at the center. These slopes vary from the edge of the film to the center approximately as does the stress S in Fig. 1. If S is used as the stress at the outer fiber and also as the tangent of the slope at the outer edge of the soap film, then, for the bar, $M_t = \frac{SI}{R}$; and for the soap film, the volume V of the paraboloid of revolution is $(\pi SR^3)/4$ or $\frac{SI}{2R}$. Thus the ratio of M_t to V is 2 to 1.

For a rectangular area, Fig. 3, the soap film coincides approximately with that area generated by sweeping a parabolic template along the breadth, b, of the rectangle. Thus the volume is approximately the end area, A, times the length b. In an angle used as a lintel, Fig. 4, the volume would be the end area, A, times the total length of the two legs. In a slotted pipe, Fig. 5, the volume would be generated by a similar area sweeping the entire circle less the slotted opening. Values of parabolic end areas are computed by $A = \frac{c^2S}{6}$.

A question yet to be answered is, what slope—or stress—shall be taken, at the edge of the parabola—that is, at the outside of the section? If a slope is taken arbitrarily equal to the desired stress, the volume generated will equal $M_t/2$. The slope, and consequently the stress, will be greatest at that point on the periphery nearest to the high point on the soap film; that is, in Fig. 3, at the middle of the long edge of the rectangle; in Fig. 4, at the reentrant angle of the angle bar; and in Fig. 5, inside the pipe. At a sharp corner the film slope would be zero; at a reentrant corner it would be infinite. As a check for these maximum slopes or stresses, Timoshenko and MacCullough on page 78 of their *Elements of Strength of Materials* give $S = 3M_t/bc^2$ or $M_t = \frac{Sbc^2}{3}$ for a bar in which $\frac{b}{c} > 10$. This should, and does, equal twice the volume having an end area $A = \frac{c^2S}{6}$ and a length b. For a b/c ratio of 3, the true maximum stress is 22 per cent greater. A square bar gives results of $M_t = {}^1/_3Sc^3$, 38 per cent large. Fillets in structural shapes usually more than compensate for this end effect.

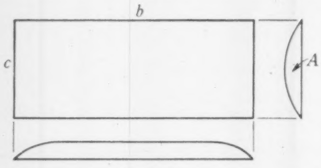


FIG. 3

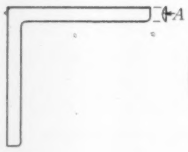


FIG. 4

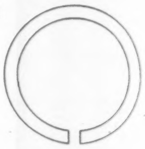


FIG. 5

If a section involves varying widths, as the T section in Fig. 6(a), it must be remembered that a soap film has equal stress or tension T in all directions, and that the pressure causing the film to bulge is uniform. Consider two cables uniformly loaded in their horizontal projections, of spans b' and b'', with the same end-tensions T, Fig. 6(b) and (c). How will their end slopes, S, and the areas of sag, A, compare? The values for S will be comparable with the stresses along the stem and along the top, while the areas of sag, A, will be comparable with the two generating areas. The sine of the angle of slope is $pb/2T$, and for small angles the slope is proportional to

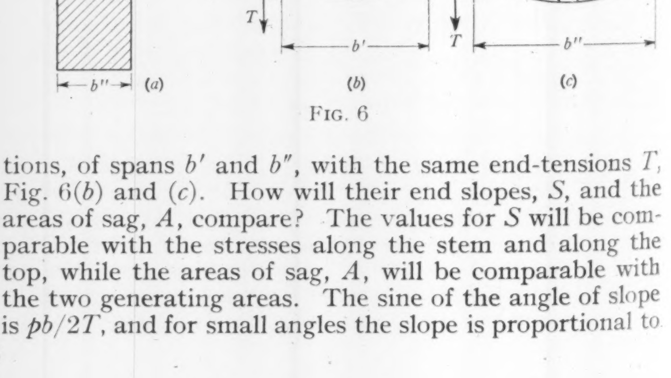


FIG. 6

the widths, b. The areas will be proportional to the cubed widths. Thus the end templates for generating the various volumes are defined.

For a hollow shaft, the volume within the membrane would be a paraboloid of revolution of the outside diameter, D, minus a portion of the same paraboloid of revolution with a base equal to the inside diameter, D_1, Fig. 7. Thus a hollow shaft with an inside diameter equal to half the outside diameter has lost only one-sixteenth of its torsional strength.

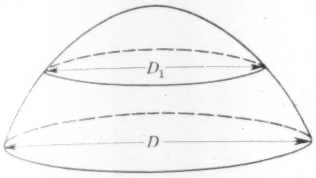


Fig. 7

Thinking in terms of plastic behavior, it may be granted that the stress throughout a shaft at incipient torsional failure is constant and equal to the yield stress. Representing such a stress with a similar analogy would give a cone with sides of uniform slope, Fig. 8(a), instead of a parabaloid of revolution. The volumes and slopes for yield stress may be derived by dipping a template—shaped like the end of the shaft or bar considered—into fine sand and bringing it up with a cone, pyramid, or other solid of sand resting upon it, Fig. 8(a) and (b). The angle of repose of the sand fixes the side slope of the solid and is proportional to S_y, the yield stress of the material constituting the bar, Fig. 8(c). This concept is most illuminating when applied to sections representing shafts with keyways, notches, fluting, or to a concrete pier subject to torque and having a chase or ladderway cut into the sides.

To carry the analogy a bit further, tap a template with its cone of sand lightly. Note, Fig. 8(d), that the vertex of the pyramid or cone becomes rounded and the rounding progresses outward to the edges. The maximum slope persists for some time about the keyways and the middle of the long straight edges. This breaking down of the maximum slope occurs in just the reverse order to that in which the yield stress, with an increasing torque, would be reached and would progress in case of failure.

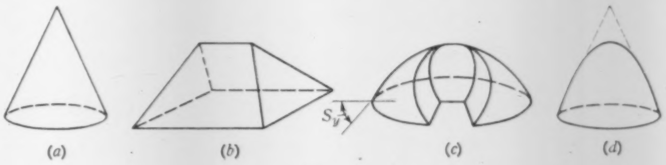


Fig. 8

The preceding concepts are given, not as applicable to marginal design, but in appreciation of the fact that most design is liberal. It would seem better for all engineers to have an "80 per cent accurate" concept of a problem than for most of them to have no grasp of the situation. Factors of safety are admissions that ability to foresee all probable contingencies is less than half reliable.

Graphical String-Lining of Railroad Curves

By John C. McCoy

Formerly Transitman, Missouri Division,
Atchison, Topeka, and Santa Fe Railway

This method of string-lining is applicable to every case, and of particular advantage for curves that are difficult owing to length, compound nature, bad state of alinement, or the presence of immovable objects which limit the throw. In any case it is advantageous because of the uniformity to be obtained, the scarcity of computations involved, freedom from confusion as to signs, and the extent to which track throw can be kept to the minimum.

It is assumed that the reader is familiar with the general principles and merits of string-lining, the way to measure mid-ordinates and to set the stakes from the throws derived. The following explanations are predicated upon the use of 31-ft stations and mid-ordinates in tenths of an inch (except as mentioned in the final paragraph).

In the example presented here the existing alinement was bad, and the problem was further complicated by the presence of a bridge, over which the throws had to be held to the lowest possible amount. The stations were measured from the center of the bridge to the near end of the curve, and the station numbering was carried back from that end through the curve. This placed the limiting object as near as possible to Station 0, as should always be the case.

On graph paper with 6 divisions to the inch, the measured ordinates were plotted (Fig. 1). The stations run from right to left, two spaces to the station; the ordinates are vertical, one space per ordinate. This plotting is easily done by use of the ordinate scale on the "Throw Computer" (Fig. 2). Each plotted ordinate is enclosed in a small circle, and after the plotting has been checked, the circles and connecting lines are inked to withstand erasure.

BEGINNING with this issue, reprints of the complete Engineers' Notebook department are to be made available each month at 15 cents a copy. They will be trimmed to $8^1/_2$ by 11 inches in size, to make them suitable for binding in loose-leaf notebooks.

Reprints of individual Notebook articles cannot be supplied.

The plotted curve resembles a profile, on which "grade lines" to represent the spirals and the curve proper are laid so as to strike an approximate balance between "cuts" and "fills." The spiral slope is governed by the railroad's requirements with respect to spirals and by the probable speed of trains. The angle of slope is best reckoned in terms of the maximum interval, V, between ordinates at adjacent stations. In Fig. 1 the speed of trains was 55 miles per hour; the corresponding value of V for equilibrium speed is 3, and the spiral slope was laid out accordingly.

The "grade lines" for spiral A and the curve proper should be drawn with a sharp pencil; dots should be placed at the intersections with the vertical station lines and enclosed in small squares. These dots, indicating the mid-ordinates of the proposed curve, should preferably be placed exactly upon the horizontal lines nearest such intersections, but if greater precision requires, they may be placed midway between the horizontal lines.

The throw computer (Fig. 2) is a measuring device made to the same scale as the graph. Its ordinate scale contains plus and minus readings in distinctive weights (or colors), and it may be used to great advantage in all plotting and scaling of ordinates, as well as in the computation of throws. On its station scale the stations are numbered in reverse direction from those on the graph, and immediately below each station is the cumulative sum of stations up to and including that point. It can be used advantageously in scaling horizontal distances and in counting ordinates, as well as in computing throw reductions.

The throw at the extreme right (Station 0 in Fig. 1) is always zero; likewise at the next station to the left (Station 1). From this start, the throws are derived easily, rapidly, and accurately, station by station, in the following manner, as illustrated by the derivation of the throw for Station 7:

1. Place pencil point on dot in square at Station 6.
2. Set ordinate scale reading +3 (the throw at Station 6) at pencil point.
3. Move pencil point to +5 (the throw for Station 5), and hold it there until Step 4 is completed.
4. Slide the computer upward until +3, the throw at Station 6, is at the pencil point.
5. Note the reading (−2) that appears opposite the circle, and record it as the throw for Station 7.

Following such procedure, −13 was derived for the throw at Station 10, the center of the bridge. The throw at that point was reduced to zero in the following manner. The station scale was laid horizontally along the base line, its foot at Station 10. It was found that by subtracting the cumulative sum at Point 4 from that at Point 8, a remainder of 26 was obtained (36 − 10 = 26), or twice the desired amount of change. It was also noted that if the proposed ordinates (squares) at points 5, 6, 7, and 8 (Stations 5, 4, 3, and 2 on the graph) were each lowered a half-space, no serious damage would be done to the spiral. They were therefore so lowered, and enclosed in triangles to distinguish them from their original positions. By means of the throw computer, this time applied to triangles where such existed, the revised throws were then derived from Station 3 to Station 10. The securing of zero at Station 10 was a check upon the correctness of the work. A part of the crew could now begin to set the stakes.

The derivation of throws was then continued to Station 23, or one station beyond the apparent end of the curve proper. At Station 23 a throw of +48 was derived, making it evident that there must be considerable reduction, both for the sake of economy in track costs and in order to close the curve with zero for the final throw. The throw at Station 23 was reduced to the neighborhood of zero (actually to +3) by the same general process as that described for the reduction at Station 10. In this case, the proposed ordinates at Stations 18, 17, 16, 15, 14, and 13 were raised one whole space each, and enclosed in triangles. The revised throws were then derived from Station 14 to Station 23, at which point the correctness of the work was again checked by the derivation of the expected throw.

To complete the curve with spiral *B*, some computations are necessary. The values of the latest ordinates in spiral *A* are set down in a vertical column at the right, and their sum (t') ascertained. The sum (t'') of the latest ordinates in the curve proper is derived, as shown by the computations at the bracket in Fig. 1. The self-explanatory computations in the upper left corner of the graph constitute the solution of the following equation in which L is the length in stations of spiral B; T the sum of the measured ordinates for the whole curve; t the necessary sum of ordinates in spiral B; and M the top ordinate in spiral B:

$$L + 1 = \frac{2t}{M} = \frac{2[T - (t' + t'')]}{M}$$

In laying the "grade line" for the closing spiral it should be drawn lightly, for it is quite likely that the first approximation will have to be erased. By means of that line, however, the top ordinate, M, can be spotted. In Fig. 1, M was 20 at Station 23. $L + 1$ was found to be 8.3. Thus L was 7.3. This distance was measured along the base line from Station 23, and the foot of the true spiral established. Spiral *B* was then drawn between its foot in the base line and the top ordinate at Station 23; dots and squares were placed; and the values of the ordinates set down in a vertical column at the left. Their sum must equal t as previously determined. In Fig. 1, the check was perfect, as it usually will be if the work is carefully done. If there had been a slight discrepancy, one or more of the ordinates in spiral *B* would have been raised or lowered sufficiently to produce the required sum, care being taken to do as little violence as possible to the uniformity of intervals.

The throws for the remainder of the curve were then derived. The final throw at Station 31 turned out to be +10. It will be observed that the throw at Station 30 is also +10. In other words, there is a repetition of throws at the end

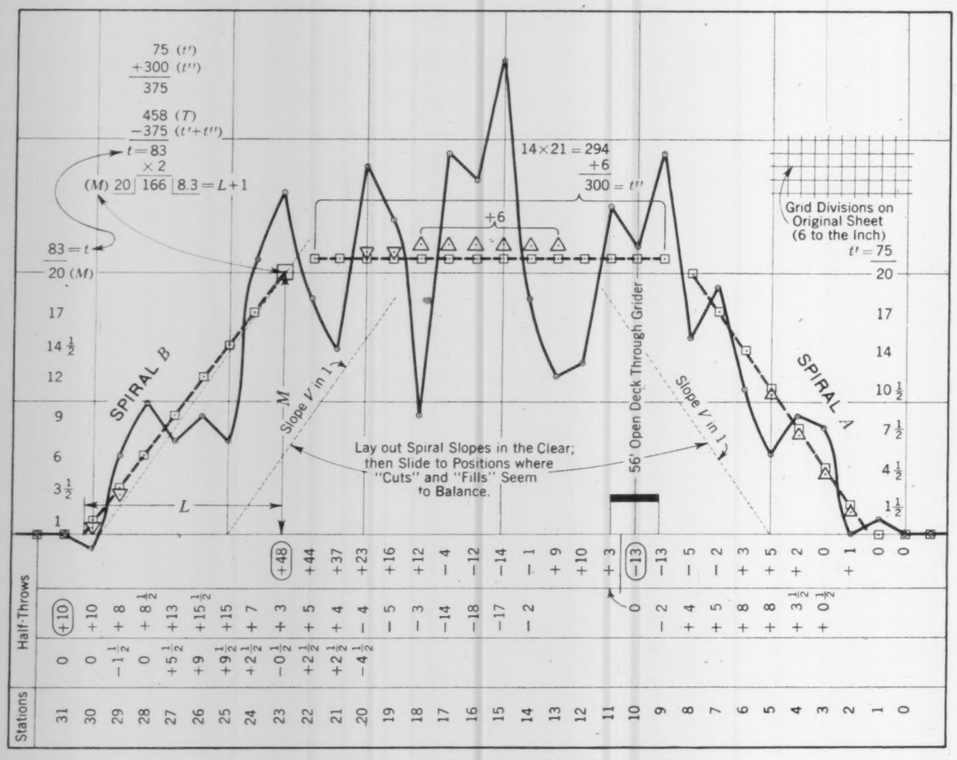


FIG. 1. ILLUSTRATIVE PROBLEM IN STRING-LINING

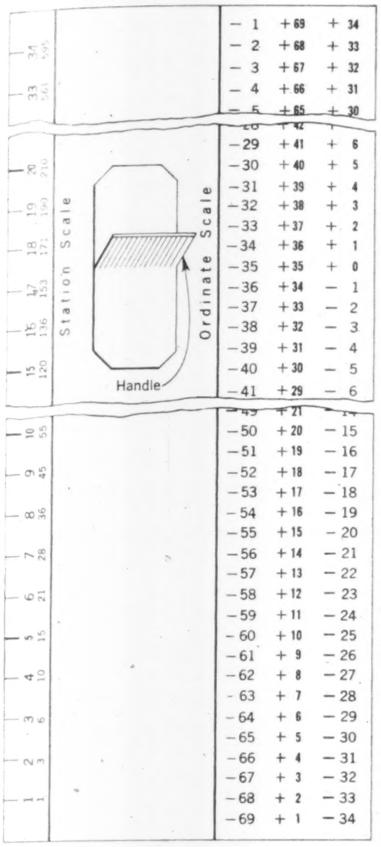


Fig. 2. Throw Computer

When Readings Exceed 35, or Will Do So When Slide Is Made, Use the Proper Inner Column

of the curve. That condition always prevails if the work is correctly done; hence the correctness of the work is checked if such repetition occurs.

The final throw must always be zero. In Fig. 1 the necessary reduction was made by raising the ordinates at Stations 19 and 20 a half space each and by lowering those at Stations 29 and 30 a like amount. Measuring with the station scale, it was found there was a distance of 11 stations from Station 30 to Station 19, and of 9 stations from 29 to 20. This made a total of 20, or twice the required amount of reduction. By raising and lowering the ordinates half spaces at these points, the exact amount of change was made up. The decision to make the changes at these points was clinched by the observation that it would do no appreciable damage to the smoothness of the alinement to make them there. The changed ordinates were enclosed in inverted triangles, and the revised throws derived from Station 20 to Station 31. The derivation of zero for the final throw was a complete and final check upon the work.

Attention is called to the fact that, in the final changes to close the curve, raised ordinates must be exactly counterbalanced by lowered ordinates, and vice versa. Otherwise, the sum of the ordinates in the new curve would not equal T, the sum of the measured ordinates in the existing curve, and such equality must always prevail. It is also pointed out that where minus throw is to be reduced, as at Station 10, ordinates to the right are lowered; and where plus throw is to be reduced, as at Stations 23 and 31, ordinates to the right are raised.

In looking over the squares and triangles it will be seen that, in view of the bad state of alinement to be dealt with, a remarkably uniform curve was obtained. The only flaw is the fact that from Station 5 to 6, V equals $3^1/_2$ instead of 3. However, this is still well within the limits of safety. Had it not been for the bridge, the new alinement would have been better still.

The realinement of compound curves can be made almost as deftly as in the case of simple curves. The only difference in the process is the inclusion of a spiral line between the component parts of the curve proper. It is doubtful whether curves and spirals can be so nicely adjusted to the existing alinement and to limiting objects by any other method, transit included.

The throws derived by the foregoing explanations are half throws in tenths of an inch, and must therefore be multiplied by 2 to obtain the whole throws for setting the stakes. When the curvature does not exceed 1° 30′ it is recommended that the mid-ordinates be measured in twentieths of an inch. In that event the value of V would be multiplied by 2 to get the spiral slope, and the throws then derived would be whole throws in tenths of an inch.

Deflection of Free-End Column or Hanger with Eccentric Load

By E. R. St. John, M. Am. Soc. C.E.

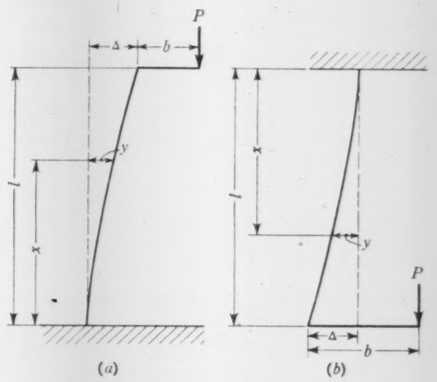
Consulting Engineer, New York, N.Y.

In some handbooks the deflection of an eccentrically loaded free-end column is given as

$$\Delta = b\left[\frac{1}{\cos(l\sqrt{P/EI})\,\dfrac{180}{\pi}} - 1\right] \ldots\ldots [1]$$

This equation is not adaptable to hangers, and it is not very convenient for columns. It cannot be used for determining the elastic curve, or the tangent to the elastic curve, without being differentiated. Further, to compute a deflection, the denominator must be reduced to an angle in degrees, minutes, and seconds, and the cosine of this angle found. The simple expressions developed herein for both columns and hangers should therefore be of value.

On the theory that flat curves coincide, it is assumed initially that the elastic curve (Fig. 1) is a parabola—that is, that $x^2 = fy$. Then $l^2 = f\Delta$, and $y = x^2\Delta/l^2$.



(a) (b)

Fig. 1. Free-End Column (a) and Hanger (b) with Eccentric Load

For the column, $M = Pb + P\Delta - Py$. Hence

$$\frac{EI}{P}\frac{d^2y}{dx^2} = b + \Delta - \frac{\Delta x^2}{l^2}$$

and, integrating,

$$\frac{EI}{P}\frac{dy}{dx} = bx + \Delta x - \frac{\Delta x^3}{3l^2} + c_1 \ldots\ldots\ldots [2]$$

When $\dfrac{dy}{dx} = 0$, $x = 0$, so $c_1 = 0$. Integrating again,

$$\frac{EI}{P}y = \frac{bx^2}{2} + \frac{\Delta x^2}{2} - \frac{\Delta x^4}{12l^2} + c_2$$

When $y = 0$, $x = 0$, so $c_2 = 0$. Also, when $x = l$, $y = \Delta$. Substituting and solving,

$$\Delta_{\text{column}} = \frac{6Pbl^2}{12EI - 5Pl^2} \ldots\ldots\ldots\ldots [3]$$

Equations 1 and 3 vary by about 0.5 per cent in exaggerated cases, and in ordinary cases practically agree.

For the hanger, $M = Pb - P\Delta + Py$, and by a similar development,

$$\Delta_{\text{hanger}} = \frac{6Pbl^2}{12EI + 5Pl^2} \qquad [4]$$

The maximum tangent to the elastic curve, for the column, is obtained by substituting l for x in Eq. 2, and is expressed by $\frac{Pbl}{EI} + \frac{2P\Delta l}{3EI}$. For the hanger, the maximum tangent is $\frac{Pbl}{EI} - \frac{2P\Delta l}{3EI}$.

Diagram for Use with Cross Method Simplifies Solution of Flow Networks

By ELDON R. DODGE, JUN. AM. SOC. C.E.

INSTRUCTOR IN HYDRAULIC AND SANITARY ENGINEERING, UNIVERSITY OF WISCONSIN, MADISON, WIS.

THE following discussion presents a technique worked out by the writer for use with the Cross method of solving problems in flow through conduit networks. For a detailed explanation of the method itself, the reader is referred to *Analysis of Flow in Networks of Conduits or Conductors*, by Hardy Cross, M. Am. Soc. C.E. (Bulletin No. 286, Engineering Experiment Station, University of Illinois).

The fundamental equation upon which Professor Cross's analysis is based is

$$h_f = r\,Q^n \qquad [1]$$

where r is the loss of head in the pipe for unit quantity of flow (r depends on the length, diameter, and roughness of the pipe). This is of course a special case of the more general form,

$$h_f = k\,L\,\frac{Q^n}{D^p} \qquad [2]$$

The method of "balancing heads" is essentially as follows. An arbitrary distribution of flow is assumed in the network, making the inflow exactly equal the outflow at each junction. Then for each loop two paths of flow are apparent, one clockwise and the other counterclockwise. A value of h_f will result for each path of flow, and the difference in the two values can be denoted by Δh. From Eq. 2, neglecting terms of second order and higher,

$$\frac{\Delta h}{\Delta Q} = n\,k\,L\,\frac{Q^{n-1}}{D^p} \qquad [3]$$

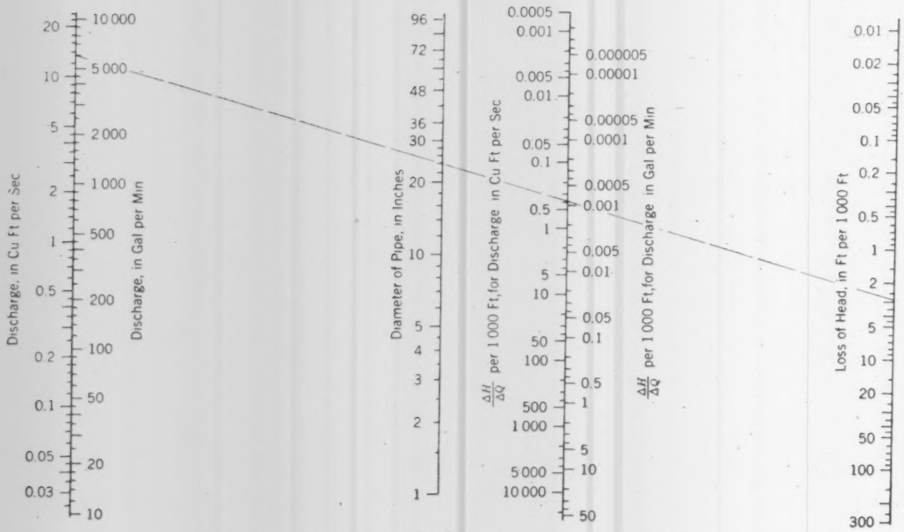


FIG. 1. CHART FOR VALUES OF h_f AND $\Delta h/\Delta Q$

From Δh and Eq. 3, ΔQ can be calculated as

$$\Delta Q = \frac{\Delta h}{\frac{\Delta h}{\Delta Q}} \qquad [4]$$

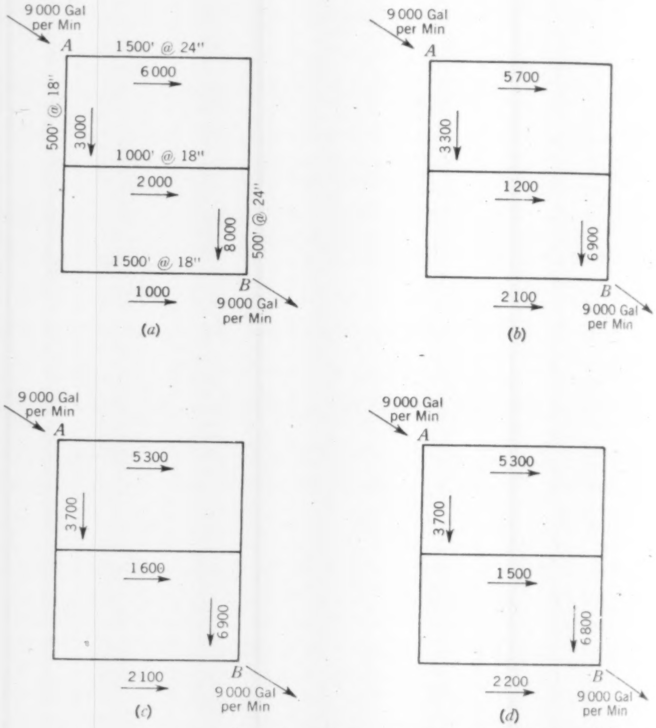


FIG. 2. TYPICAL PROBLEM, SHOWING INITIAL ASSUMPTIONS AND THREE SUCCESSIVE APPROXIMATIONS

ΔQ is a correction to the assumed distribution of flow in the loop, and its direction is indicated by the path giving the least value of h_f.

Fig. 1 presents a diagram from which values of h_f and $\frac{\Delta h}{\Delta Q}$ can be read directly. This chart has been constructed on the basis of the Hazen-Williams formula, $v = 1.318\,c_1 R^{0.63} S^{0.54}$, with $c_1 = 120$. The following example will illustrate the use of the diagram and method of calculation.

Let it be required to find the distribution of flow in the pipe layout shown in Fig. 2(a), with inflow at A of 9,000 gal per min, and outflow at B of the same amount. Pipe sizes and lengths are shown on the sketch. As a first approximation, assume the distribution of flow shown in Fig. 2(a). From Fig. 1, h_f for the upper loop, clockwise, is found to be 1.5×2.8, or 4.2 ft; and, counter-clockwise, it is $0.5 \times 3.2 + 1.0 \times 1.5 = 3.1$ ft. Therefore $\Delta h = 4.2 - 3.1 = 1.1$. The value of $\Delta h/\Delta Q$ is also computed from Fig. 1 as $1.5 \times 0.0009 + 0.5 \times 0.0020 + 1.0 \times 0.0014 = 0.0037$. Consequently ΔQ, the correction, is 1.1/0.0037, or 300 gal per min, counter-clockwise. By similar computations, ΔQ for the lower loop is found to be 1,100 gal per min counter-clockwise. Fig. 2(b) shows the distribution corrected as a result of this calculation.

Using these flows for the second approximation and proceeding as before, ΔQ for the upper loop is 400 G/M counter-clockwise, and ΔQ for the lower loop is zero. The new distribution is shown in Fig. 2(c).

In the third approximation, the values of ΔQ for the upper and lower loops are zero and 100 G/M counter-clockwise, respectively. In Fig. 2 (d) is shown the final distribution of flow—which, it is noted, is little different from that obtained as the result of the second approximation.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Marine-Borer Investigation in Boston Harbor

To the Editor: The paper on "Recent Increases in Marine-Borer Activity" by William F. Clapp, in the December issue, is interesting and instructive, and the profession owes much to him for the time and advice which he has given in connection with the investigations of marine-borer activity in New England.

Previous to about 1930, damage to Commonwealth piers in Boston Harbor by marine borers was not considered serious. In 1925 an examination of 118 piles was made in one day by diver, and of these it was found that in round figures 45 per cent were sound and 55 per cent were damaged by marine borers. During the year 1932, while repairs were being made to the pile and timber foundations of the platforms at Commonwealth Pier 5, South Boston, it was found that practically all of the main piles pulled from under the west platform and one from the east platform were badly eaten by limnoria. Thereafter an examination was made by diver, and of 484 foundation piles examined 10 per cent were found to be sound and 90 per cent more or less eaten. This indicated that the destruction had continued. Recommendations followed for the reconstruction of the foundations of these platforms.

In cooperation with the New England Committee on Marine Piling Investigation, the Massachusetts Department of Public Works has monthly removed and replaced blocks on control boards and sent them to Dr. Clapp's laboratory for examination and report. The Department has four stations in Boston Harbor—one at Quincy-Weymouth Fore River Bridge, one at Commonwealth Pier 5, South Boston, one at Commonwealth Pier 1, East Boston, and one in South Bay, Roxbury. The results of examinations of these test blocks are published from year to year by the New England Committee on Marine Piling Investigation.

In 1936 the General Court appropriated $15,000 for the inspection of structures in tide-water, $10,000 being for Boston Harbor and $5,000 for waters outside Boston Harbor. Inspection of structures is made by a construction inspector and diver, the former examining the portion above water and the diver the portion under water.

During the examination the diver takes samples with increment auger and also by cutting surface pieces from the piles. No biological examinations of these samples are made, and the kind of borer working is determined by the inspector. Limnoria and chelura, are active borers in Boston Harbor. Of the many samples taken only one showed the presence of teredo.

In Boston Harbor the diver has examined 27 structures as follows: in Boston 16, in South Boston 4, in East Boston 5, and in Chelsea and Charlestown one structure each. Of these structures, more than 10,000 piles out of a total of about 23,000 piles have been examined. Of these about 7,600, or about 74 per cent, were found to be in good condition, and around 2,600 piles, or about 26 per cent, were damaged more or less by the borers. On an average, it appears that about $7^1/_2$ per cent of the cross-sectional area of the piles examined had been eaten away. As the examination of structures is in progress these figures should be considered preliminary.

John N. Ferguson, M. Am. Soc. C.E.
District Waterways Engineer,
Massachusetts Department of Public Works

Boston, Mass.
March 31, 1938

Computing Length of Brace for Howe Truss

To the Editor: The article by Russell Chase, Assoc. M. Am. Soc. C.E., in the September issue, describing a method for determining the length of a brace for a Howe Truss, has aroused considerable comment. Too much discussion makes a subject trite, but I should still like to present a more direct method of making this computation.

From a glance at the accompanying Fig. 1, it is obvious that the lines OM and ON are equal. Further, $(OM)^2 = (8 - x)^2 + (4^1/_2)^2$ and $(ON)^2 = (4^1/_2 - y)^2 + 8^2$. Hence, $x^2 - 16x = y^2 - 9y$. But $x^2 = (4 - y^2)$, so $(4 - y^2) - 16\sqrt{4 - y^2} = y^2 - 9y$. Squaring to remove the radical, and collecting, we have $4y^4 - 36y^3 + 321y^2 + 72y - 1{,}008 = 0$.

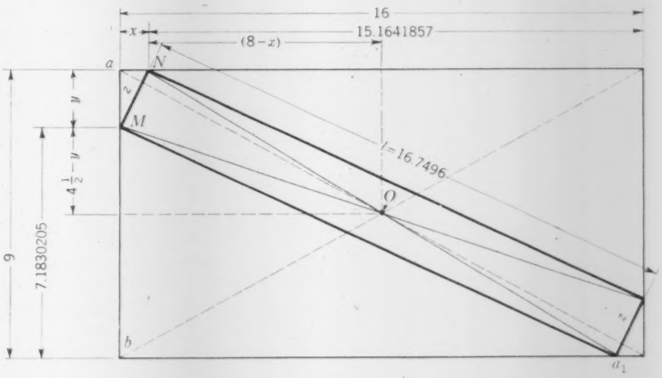


Fig. 1. Solution of Howe-Truss Problem

By Horner's method it is a simple matter to extract the roots of this biquadratic equation to any desired degree of accuracy, giving $y = 1.8169795$, $x = 0.8358143$, from which we get $l = 16.7496$.

In order to check the accuracy of these results it is only necessary to use the proportional sides of the two similar right triangles aMN and bMa_1, bearing in mind that to arrive at a complete equality it is necessary to carry the y value out to many places.

Louis L. Huot
Bridge Architect,
City Engineer's Office

Los Angeles, Calif.
March 24, 1938

Chicago and Washington Methods of Subsurface Utility Planning

TO THE EDITOR: Two divergent views regarding the most efficient method of control for the future allocation of subsurface space in urban areas were given in juxtaposition in the February issue of CIVIL ENGINEERING. The practices of Washington, D.C., and Chicago were contrasted in two well-phrased communications. In one of these J. B. Gordon, M. Am. Soc. C.E., discussed my article on "Need for Subsurface Utility Planning," in the October issue. Mr. Gordon, who gave notable assistance to the Committee on Location of Underground Utilities and played an important part in the formulation of the two manuals prepared by that Committee, has pointed out most convincingly the technique, benefits, and low cost of the Washington method.

On the other hand, in the same issue, L. R. Mapes, chief engineer of the Chicago area of the Illinois Bell Telephone Company, has presented a strong case for the "allocate as you go" method as practiced in Chicago, without central record keeping but with a central clearing house for allocation of space as individual requirements arise.

After five years of study the Committee on Location of Underground Utilities of the American Society of Civil Engineers was strongly inclined to favor the Washington, D.C., practice. There, for many years and at moderate cost (only $13,877 per annum), it has been found to be thoroughly practicable to maintain in one central office complete, legible records of all underground construction work and also to maintain master plans for future subsurface work.

My own experience in the suburban towns of the Chicago Metropolitan Area leads me to favor the Washington, D.C., method. Time and again perplexing situations involving the allocation of space for underground utilities have arisen in those towns, and in my opinion these situations would not have developed had underground planning of the Washington type been practiced in the past. Two of the most disconcerting tendencies in that area include the failure of subsurface utilities to follow straight lines in straight streets and failure on the part of all concerned to coordinate underground work with paving operations, particularly on projects involving the widening of existing pavements.

The initial development of a regional or municipal control office for keeping records of subsurface improvements and for the development of master plans for future underground work will naturally involve a considerable expense. Likewise, transition from the Chicago method to the Washington method would be costly.

However, in the unanimous opinion of the Committee on Location of Underground Utilities, whose membership was recruited from six large cities in the United States, such development or such transition is well worth what it will cost.

ARTHUR W. CONSOER, M. Am. Soc. C.E.
Chairman, Committee on Location of Underground Utilities of the American Society of Civil Engineers

Chicago, Ill.
March 22, 1938

Traffic Control and City Planning

TO THE EDITOR: The article on "Elements of Traffic Planning" by D. Grant Mickle, Assoc. M. Am. Soc. C.E., in the January issue, is an important addition to the subject of traffic planning and its relation to city planning.

Since city planning concerns itself with the use of land and location of structures, it must also concern itself with the accessibility of land and the movement of vehicles. Thoroughfares and parkways carefully laid out to connect the business district with the various residential districts are the first elements of good city planning.

The mass traffic picture of a city is represented by the traffic flow of people going to work—that is, from 7 a.m. to 9:30 a.m. In 1924, 9,791 vehicles carrying 45,434 passengers entered the business district of St. Paul in this morning period. In 1937 there were 18,760 vehicles carrying 49,412 passengers for the same period. The ratio of vehicles to passengers is increasing all too rapidly. In working out a traffic plan it is quite necessary to estimate population increases, but the important problem to decide is the number of cars that will be owned by each family in ten years, and in what part of the city this excess of cars will be.

Estimates on the cost of congestion submitted by various writers are very interesting, but I believe unprofitable. A much better approach is "convenience" without attempting to place on it a monetary value. Lack of convenience lowers rents and values and results in blight. There is a superior location for a home and a superior location for business, and these centers of superior locations should be connected by direct thoroughfares.

In every city there should be certain highways or thoroughfares which are "elements of transportation" just as a river or a railroad is such an element in the general transportation scheme. The other streets are tributaries or feeders. I consider Jefferson Avenue in Detroit such an element. This thoroughfare is comparable to Kellogg Boulevard which runs along the river bluff in St. Paul.

Mr. Mickle's traffic plan of Detroit is an excellent picture of what takes place in the majority of cities. Certain routes are favored routes—first, because they are usually stop or signal streets and the motorist always prefers a street on which cross traffic cannot enter without some warning and, second, because they are direct thoroughfares. One of the interesting peculiarities of a city is that a few streets carry the great volume of traffic. These are the streets which definitely connect the origin and destination centers. In St. Paul, for instance, 15 per cent of the paved streets carry 90 per cent of the traffic volume.

A study of the traffic flow map of Detroit (Mr. Mickle's Fig. 1) shows three diagonal routes of great importance—Michigan, Grand River, and Gratiot. The other thoroughfares are a part of the general street system. Some of them, such as Woodward Avenue, are wide thoroughfares. Also, Grand Boulevard is definitely a crosstown distributor of great value to the traffic system.

In St. Paul one of the remarkable situations is the decentralization of the industrial workers, who appear to live as far from their work as they can possibly get, and this crisscrossing of motor vehicles carrying workmen going from homes in the different parts of the city to plants in different parts of the city creates peaks of traffic movements. A check of 4,000 workers in the Midway Industrial District discloses that 27 per cent live near enough their work to walk, although very few do so; 73 per cent live a great distance from the plant they work in.

Thus it is far easier to lay out and construct bypasses in such cities. Like Detroit, St. Paul has a good supply of offstreet parking facilities in open lots and garages in the central business district. The capacity of these facilities is 8,700 cars, but the daily average use is only 5,000 cars. However, the curb space is entirely used up, and there is a great deal of illegal parking.

Spot maps of traffic accidents and fatalities kept over a number of years indicate that there are more accidents at signalized intersections than at others, and that fatalities occur at intersections where they are the least expected and where there is the least traffic. Incidentally, Mr. Mickle's reference to "accident-prone districts" is worthy of consideration. It is quite possible that those who cause accidents live in certain districts in the city, where they are not reached by the usual methods of education, such as safe driving schools. With the location of these "accident-prone districts" definitely determined, a concentrated educational campaign should be carried on.

GEORGE H. HERROLD, M. Am. Soc. C.E.
Managing Director and Engineer,
The City Planning Board

St. Paul, Minn.
March 27, 1938

Ductility of Brick Fillers

TO THE EDITOR: I should like to call attention to an error in my article on "The Manufacture of Asphalt," which appeared on page 99 of the February issue of CIVIL ENGINEERING. In Table II, sample 6 under "brick fillers," the ductility should have read 4.6 and not 46.

GENE ABSON
Chemical Engineer, Chicago Testing Laboratory, Inc.

Chicago, Ill.
March 17, 1938

Control of Marine Borers in Northern New England

To the Editor: I was interested in William F. Clapp's article on "Recent Increases in Marine-Borer Activity," in the December issue. Until recent years, northern New England was not troubled to any extent by marine borers, nor had they given us serious concern.

As a young man, I was employed by the Old Colony Railroad, and I know that the teredo was active in the waters of the Taunton River at Somerset, Mass., where the company maintained a pile bridge. They were, in fact, so active that the company put in a small plant to treat the piling used in this bridge. Aside from this one locality, I believe it was generally thought that the waters of New England were practically immune from severe attack.

To cite a case in point with which I am familiar, about six years ago the Portland Terminal Company of Portland, Me., reconstructed its extensive wharves in Portland Harbor. Before undertaking this construction, the matter of protection against marine borers was given full consideration. While there was some evidence of the action of limnoria, there was no evidence of the presence of teredo, and the new work was constructed of untreated timber. Several thousand piles were removed from the old structures and sawed into lumber or firewood. No teredo tunnels were found, although the piles had been in the water from 35 to 50 years.

Soon after the completion of these structures, we began hearing about the increased activity of borers in various places—particularly south of Boston. To make a check on the activity and habits of these borers, it was considered desirable to arrange for systematic observation and study in the territory in which we were interested. To this end, the New England Committee on Marine Piling Investigation was formed, with the late F. C. Shepherd, M. Am. Soc. C.E., as chairman, and Dr. William F. Clapp as biologist.

The original sponsors of this investigation were the Bangor and Aroostook Railroad Company, the Maine Central Railroad Company, the Portland Terminal Company, the Boston and Maine Railroad, the New York, New Haven and Hartford Railroad, the states of Maine, New Hampshire, and Massachusetts, the city of Boston, and the U. S. War Department. Valuable assistance has since been received from the United Fruit Company, the state of Connecticut, the International Paper Company, and others.

We have for the past three years maintained test boards in coastal waters from New York to Newfoundland. Test blocks from these boards are sent to Dr. Clapp monthly, and he makes his report from these. The Committee has, to date, published two comprehensive reports. That these reports have been of interest is evidenced by the fact that requests for copies have been received from Russia, Australia, and New Zealand.

We believe that as a result of these observations, we have a fairly complete knowledge of what is taking place and are resolved that any timber structure constructed in tidal waters within the limits of our observations shall be protected in some manner against borers.

Asa H. Morril, M. Am. Soc. C.E.
Chief Engineer, Boston and Maine
and Maine Central Railroads

Portland, Me.
March 30, 1938

Comments on Formulas for Combined Flexure and Direct Stress

Dear Sir: Referring to the discussion by K. L. DeBlois, Assoc. M. Am. Soc. C.E., (in the February issue) of my article on "Basic Formulas for Combined Flexure and Direct Stress," in the December number, there appears to be no necessity for the additional Eqs. 14 to 19, inclusive, suggested by Mr. DeBlois. The quantity X in my Eqs. 1 and 2 is described as "the bending moment at point (x, y) due to transverse loads or any other moment which is not a function of the deflection y." From the conditions indicated in Fig. 1 of Mr. DeBlois' discussion, the quantity X must include a term $-Pe$. Hence the term $\frac{X}{P}$ in Eq. 1 will equal $-e$, and Eq. 18 will therefore result by thus inserting in Eq. 1 the value of the bending moment $-Pe$.

I do not intend this as a criticism of the comments by Mr. DeBlois, but mention it merely for the purpose of emphasizing more strongly the possibilities offered by Eqs. 1 and 2 for the general solution of problems of this character. It may frequently happen that bending moments not a function of the deflection y must be expressed in a manner similar to that required in the case of an eccentric application of the load P or T. A case in point arises in the determination of the deflection for the cable in a suspension bridge. The expression for this deflection must include a term which is the product of the horizontal component of the cable stress by the ordinate of the dead load parabola and also a term which is the product of this same component by the deflection of the cable due to the live load.

The first of these products is not a function of y and therefore must be considered as a term in the value of X. The second product is a function of y, and therefore its integration is covered by the terms $Ae^{nx} + Be^{-nx}$ in Eq. 2.

By the foregoing consideration with regard to the eccentric condition suggested by Mr. DeBlois, the secant formula can be readily derived from Eq. 1 in my original article.

Francis P. Witmer, M. Am. Soc. C.E.
Director of Civil Engineering
University of Pennsylvania

Philadelphia, Pa.
April 2, 1938

Architectural Fundamentals

To the Editor: I was interested in the article on "Architectural Principles of Bridge Design" by Wilbur J. Watson, M. Am. Soc. C.E., in the March issue. The six principles of Vitruvius, quoted by Mr. Watson, were boiled down by Sir Henry Wotton (1624) to three: "Firmness," "Commodity," and "Delight."

Of these, "Firmness," or stability, lies in the province of the engineer. Hidden in the walls and floors of a structure lies the steel skeleton which we architects cover with flesh and skin. But just as the skeleton can be sensed within the human body, so the structure of the building should be apparent in the architect's design.

"Commodity," or the fitness of the structure for its purpose, needs the services of both engineer and architect, in proportions varying with the use of the structure. In a bridge, for instance, the grades and clearances are vital engineering elements, while in a city hall or library the dominating elements are architectural.

"Delight," or the sensation that a beholder gets from the structure, is entirely the architect's concern. This is not an absolute quality, for what is pleasing to some may seem monstrous to others. But the architect, with his esthetic training, should be better qualified than the engineer to please most of the people most of the time.

Proportion is the most important quality in achieving delight, and again we may turn to human beings for an illustration. All faces have the same features or elements; it is the proportion of these elements which makes a person beautiful or ugly. Add an inch to the nose of Greta Garbo or the Apollo Belvedere, and what have you?

Proportion is just as important in bridge design as elsewhere; and in many bridges designed without benefit of the architect, faulty proportion has made delight impossible. Perhaps the engineer felt that the problem was purely structural and that no architect's services were necessary. Instead of hiding his steel behind someone else's architecture, he joyfully grasps his chance to assert his mastery of design; and, sure enough, his steel is exposed, naked, and unashamed, for all to see. He puts in a few curves to give what he considers an "artistic" effect. But the result may well be disastrous, as he is working in a field not covered by his highly circumscribed technical training. The bridge will stand up, but it may be an abomination to all beholders. Moreover, the "artistic" features, which he may have incorporated as a concession to appearance, may better have been omitted, and the saving in cost would more than cover the small consultation fee of an architect.

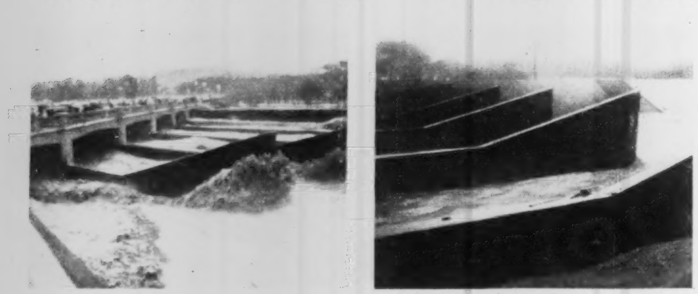
But the idea that a consulting architect can save money is difficult for an engineer to grasp, for most engineers think that architects are "soft-shell crabs," while most architects think engineers are "hardboiled eggs." As a matter of fact, members of both professions are rational human beings. Can't we get together?

Lawrence Grant White
McKim, Mead and White

New York, N.Y.
April 4, 1938

Pier Extension to Protect Bridges from Floods

TO THE EDITOR: Readers of CIVIL ENGINEERING may be interested in the accompanying photographs showing extensions of bridge piers of rather unusual shape. They were added, in January of this year, to the existing piers of the bridge over the Los Angeles River at the intersection with Los Feliz Boulevard in Los Angeles. The purpose of this construction (the protection of the bridge from possible damage due to flood) is quite apparent from these photographs showing the behavior of the river flow during the recent flood.



PIER EXTENSIONS DO THEIR DUTY IN RECENT FLOOD

These works were designed and constructed by the U. S. Engineer District of Los Angeles under the direction of District Engineer Theodore Wyman, Jr., Major, Corps of Engineers, U. S. Army.

The photographs were taken by Messrs. B. H. Dodge and G. C. Wright.

EDWARD J. BEDNARSKI, Assoc. M. Am. Soc. C.E.

Los Angeles, Calif.
March 28, 1938

Concrete Construction Costs

TO THE EDITOR: In the article on "Cutting Costs in Concrete Construction," in the April issue, Ernst Gruenwald calls attention to the various factors involved in concrete construction costs and offers in very creditable form a detailed analysis of the various conditions that may be encountered on a job, and of methods by which a contractor might determine the relative costs of alternative schedules to satisfy these conditions.

The general conclusions to be drawn from the article are that the use of high early strength cement will reduce the cost of concrete construction, where the re-use of forms is applicable—the saving being in the time costs. However, it is apparently quite difficult to set up accurate values for time costs, which are made up of such items as general overhead, job overhead, equipment charges, taxes, and insurance—especially when several operations may be carried on simultaneously. Mr. Gruenwald's figures show an extremely wide range for these costs, and a difference in the assumptions concerning them might readily affect these conclusions.

Mr. Gruenwald makes the statement "Forms are made for just one purpose—to hold "wet" concrete, that is, to act as a mold until the concrete hardens sufficiently to retain its shape."

This statement may be open to question, but if we were to accept it as wholly correct there surely could be no objection to removing forms in one or two days for the stiffer mixes and three or four days for the wetter mixes of standard cement using Mr. Gruenwald's own values for compressive strengths. The savings which are shown in the article, however, are in some instances based on the assumption that while forms for high early strength cement may be removed in one day, forms for standard cement may not be removed sooner than seven days. If this latter period were reduced to three or four days to correspond with Mr. Gruenwald's comparative values of high early strength cement and standard cement in his Fig. 1, these savings would probably be eliminated.

The characteristics and quality of standard portland cement as produced at the present time have closed, to a large extent, the gap between the early strength values of high early strength cement and standard cement. Recent tests of concrete cylinders prepared and cured under the same ideal conditions and proportions in the laboratory of the New Jersey State Highway Department using high early strength cement and standard cement from the same manufacturer give these average results:

	HIGH EARLY STRENGTH	STANDARD
7 days	6,950 lb per sq in.	6,800 lb per sq in.
28 days	9,690 lb per sq in.	8,900 lb per sq in.

Such values serve to indicate the relatively minor difference between the two types. Similar results of tests of both cements from one manufacturer for shorter periods are not available, but the same general trend would no doubt be evident in them.

Mr. Gruenwald makes no mention of the behavior of early strength concrete during the curing period, and it is probable that others have not had the unfortunate experiences which we have met in its use in bridge decks. In spite of the most rigid inspection in grading and proportioning, and supervision of placing and curing, these slabs have shown extensive crazing and checking under favorable weather conditions even during the setting period. We can no longer accept the producer's explanation of faulty workmanship or supervision. Unless this defect can be eliminated, we would suggest research on the part of cement manufacturers to determine the effect of the addition of various quantities of standard cement to specified mixes, if high early strengths are to be attained. It is our feeling that all of the advantages of economy and time may thereby be gained without probable future disappointment in durability.

MORRIS GOODKIND, M. Am. Soc. C.E.
Bridge Engineer, New Jersey State Highway Department

Trenton, N.J.
April 13, 1938

Birthplace of William Price Craighill

TO THE EDITOR: Your fine article on William Price Craighill, twenty-fourth President of the Society, in the March issue of CIVIL ENGINEERING, is in error about his birthplace—where he was buried.

That was not Charleston, but Charlestown (formerly also spelled Charles Town) in Jefferson County—Virginia, at the time of his birth, and West Virginia, when he died. Charlestown is in the beautiful Shenandoah Valley that he loved so well. Charleston, the state capital, is on the Great Kanawha River (west of the Allegheny Mountains), along which he built the locks and dams.

My first acquaintance with General Craighill was in the early nineties when I was chief engineer of the Chesapeake and Ohio Railway Company and he lived in Baltimore. He was a fellow member of the Westmoreland Club here and had a host of friends in this city. Being originally from the Shenandoah Valley myself, we had much in common to discuss during our leisure hours in that delightful old club where he was greatly missed in after years.

Aside from his engineering abilities and achievements, he was a man of commanding presence and charming personality.

HARRY FRAZIER, M. Am. Soc. C.E.

Richmond, Va.
April 7, 1938

Determining Areas for Semi-Tangents

DEAR SIR: I was interested in the article entitled "Template for Rounding Cut Slopes in Highway Construction" by Milton Harris, Assoc. M. Am. Soc. C.E., in the April issue.

His template, worked up for 5-ft semi-tangents, is the same as that used by the Arizona State Highway Department. In connection with its use we have found the following rule to be of value: "To determine areas for semi-tangents other than 5 ft, square the semi-tangent, divide by 25, and multiply by the area indicated on the template."

As the length of the semi-tangents and the amount of rounding required is governed by the depth of the cut, the usefulness of the gage is thus increased. The indicated computations can be done on a slide rule in the field.

CLIFFORD B. POTTS, Assoc. M. Am. Soc. C.E.
Arizona State Highway Department

Holbrook, Ariz.
April 2, 1938

SOCIETY AFFAIRS

Official and Semi-Official

Jacksonville Entertains

Florida Engineers Are Host to Joint Gathering of the Society and Other Groups, April 20–23, 1938

Florida engineers thoroughly upheld the South's reputation for hospitality in their handling of the 1938 Spring Meeting of the Society, which was held in Jacksonville, April 20–23. It was the first time an all-Society meeting had been held in that state, and the occasion was notable in addition for the cooperation of three other organizations—the Florida Engineering Society, the American Shore and Beach Preservation Association, and the Jacksonville Engineering Professions Club.

The meeting opened on Wednesday morning with a general session that included messages of welcome from the president of the Florida Engineering Society, the Mayor of Jacksonville, and the Governor of the state, and set the stage for the technical sessions of the following day with a series of papers on Southeastern industrial problems and developments. One action of timely interest taken at this session was to send a message of congratulation and esteem to the University of Illinois on the occasion of its designation of the Arthur Newell Talbot Laboratory for testing in honor of the Society's illustrious Past-President and Honorary Member.

Simultaneously, representatives of the Student Chapters in the Southern Region convened to discuss their own problems and to hear a program of papers by their own members. This session adjourned in time to permit the delegates to join the older men for a special students' luncheon. After seven life members of the Society had been presented, student members were introduced from the Agricultural and Mechanical College of Texas, Louisiana State University, Alabama Polytechnic Institute, Georgia School of Technology, Virginia Polytechnic Institute, and Tulane University. In all, about 60 students enjoyed this program and the preceding talk built around the younger man's interest in his profession.

Following the luncheon, the members and their guests left by motor for a tour of historic St. Augustine. The party returned by the road bordering the shore, stopping to enjoy a buffet supper and dance at the Ponte Vedra Bath Club.

On Thursday, resisting the lure of the Florida spring weather, the engineers turned to the consideration of technical matters. Four Divisions held double sessions—morning and afternoon—that with only a brief recess for luncheon lasted from 9:00 a.m. until well on towards the supper hour.

The Surveying and Mapping Division had a schedule of five papers, which dealt with such problems as the adjustment of old surveys, the establishment of plane coordinate systems, and the improvement of land surveys and title transfers. Six papers were presented before the Sanitary Engineering Division; the topics included hydrology, water supply, sewage disposal, and malaria control.

Meeting jointly with the American Shore and Beach Preservation Association, the Waterways Division gave special attention to beach-protection work from points as widely separated as Massachusetts, Texas, and California. Two papers on harbor and river improvement projects were also on the schedule.

At the morning meeting of the Highway Division, questions of highway economics, construction, and safety were discussed. In the afternoon, materials of construction, soil stabilization, and methods of soil sampling and testing were the topics of interest.

Concurrently with the Division sessions, the Florida Engineering Society was conducting meetings for its electrical and mechanical engineering members in a neighboring hotel. The various groups assembled again in the evening for the outstanding social event of the meeting—the dinner dance at the headquarters hotel.

For the ladies, of course, entertainment had been provided throughout the period of the meetings—sightseeing trips, teas, and a variety of informal gatherings.

Early on Friday, the visitors and their hosts left by special train for an all-day excursion to Ocala and the famous Silver Springs nearby. Many were entertained the following day with a series of inspection trips to nearby points of interest.

Although the Jacksonville Meeting was under joint management, the details were carried out with perfect understanding and coordination. To the Jacksonville Engineering Professions Club was assigned the task of entertainment, registration, finances, and publicity. Its job was most commendably done. Technical sessions and excursions were planned under the jurisdiction of the Society, the Florida Section, and the Florida Engineering Society. The latter group also handled its own individual sessions. Finally the American Shore and Beach Preservation Association cooperated in the meetings of the Waterways Division. In thus assessing the credit for the outcome, generous acknowledgment must be given for the capable handling of the arrangements for the ladies, which were fully equal to those for the general meetings.

In short, this first experience of the Society in Florida was a delightful occasion from every angle. The registration of over 600 is a significant gage of its outstanding success.

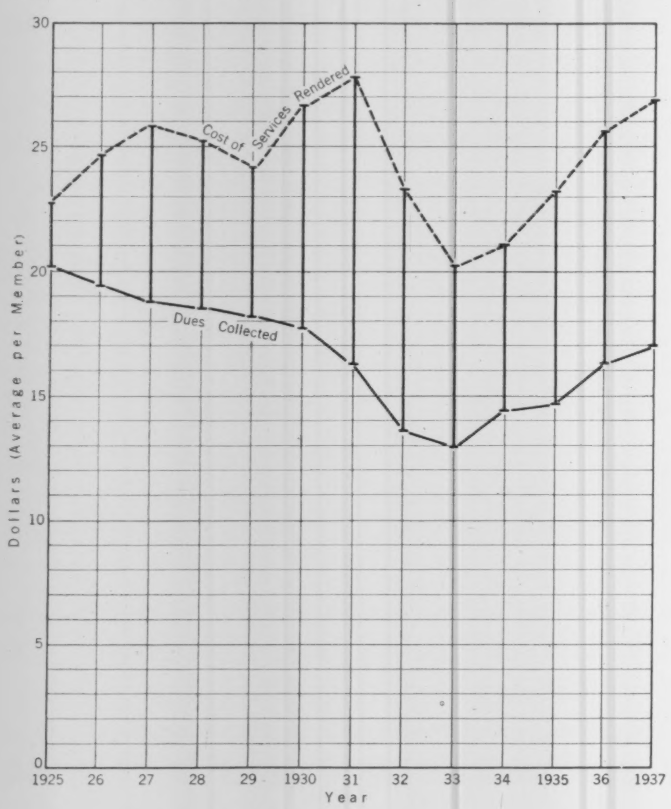
Jacksonville, Fla., Scene of the 1938 Spring Meeting

A Local Attraction Not on the Official Program

An Analysis of Society Finances

The Board of Direction at its request had submitted to it in October, 1937, a report on Society finances by a committee composed of Directors Myers (chairman), Dean, and Needles. Its principal details, it was believed, would be of interest to the members and were ordered printed. Without material changes as to substance, they are here set forth with additional data as for 1937.

FOR the Society to expend in any one year $1.68 in services to members for each $1.00 collected in dues from members implies that it has other sources of income or that it must draw upon accumulated funds. This was the rate of expenditure in 1937, and it was made possible primarily by income from investments and publications. With draft upon accumulated funds, services were rendered in 1931 and 1932 in the ratio of $1.71 for each $1.00 collected in dues.



DUES RECEIVED AND SERVICES RENDERED, IN DOLLARS PER MEMBER PER YEAR, 1925 TO 1937

The Society has investments which have yielded annually, since 1929, in the neighborhood of $70,000. It derives income also from advertising in CIVIL ENGINEERING, from the sale of its publications, and from entrance fees and similar items.

"WHAT DOES THE MEMBER GET FOR HIS TWENTY DOLLARS?"

The question has been asked, "What does the member get for his twenty dollars?" Looking at it from the Society's point of view, the dues collected from the "average" member differ materially from $20.00. In 1925 the total dues collected averaged $20.10 per member, but in succeeding years it diminished steadily—and during the depression, in 1933, reached a low average of only $12.98. In 1937 an average of $15.98 per member was collected.

On the other hand, the members received services costing $22.75 per member in 1925; $28.85 in 1931; $20.06 in 1933; and $26.86 in 1937. Reduced to cost of services rendered per $1.00 of dues collected, these figures become $1.13 in 1925; $1.71 in 1931 and 1932; and $1.68 in 1937.

CHANGE IN AVERAGE DUES

The steady decrease in average dues is to be attributed largely to the substantial change in the percentage of Juniors in the Society. In 1925 Juniors constituted 6.9 per cent of the membership, whereas in 1937 they formed 23.3 per cent. Another factor in the decrease in average dues during the depression was the generous manner in which the Board handled cases of arrears. In 1931, 1932, and 1933, members who reported difficulty in paying their dues were excused therefrom if they had previously paid dues a given number of times. In 1933 more than 2,700 members were thus exempted. In subsequent years, with return of employment, the provisions with respect to arrears were tightened gradually with resulting increase in dues collected. During the seven years 1931–1937 inclusive, dues were canceled in 11,037 instances, to a total of about $213,000.

WHAT SERVICES ARE RENDERED?

When one suggests a "functional" break-down of expenses, the thought is to inquire what the money is spent for. It is difficult to determine, however, where to draw the lines between functions, and it is still more difficult to determine to what extent each function should share in carrying the general or overhead costs; hence any such functional break-down at best contains many assumptions. In the present inquiry certain major items of the budget were selected as the functions to be analyzed and it was decided not to obscure them with assumed allocations of general or overhead expenditures. The details of the break-down, in terms of income and expenditures per member for 1925 and 1937, are shown in Table I.

TABLE I. SOCIETY INCOME AND EXPENDITURES IN DOLLARS PER MEMBER, 1925 AND 1937

All Figures Are Taken from the Annual Reports

INCOME	1925	1937
Dues	$20.10	$15.98
Investments	3.46	4.39
Technical publications, meetings, and contributions for use of committees	2.57	5.10
Entrance fees and individual services	2.06	1.70
Total income	$28.19	$27.17
EXPENDITURES		
Technical publications, technical committees and divisions, general publications and printing	$ 8.40	$10.84
Salaries, rent, travel, telephone, supplies, equipment, postage, etc.	8.07	8.77
Meetings, general service to members, Local Section support, admissions and transfers, and misc.	6.28	7.25
Total service to members	$22.75	$26.86

Income and expenditures materially lower than those shown in Table I prevailed in the depression years. Among the income items, receipts from dues was the most seriously affected. On the other hand, expenditures were decreased by reductions, chiefly in the salaries of the staff, rent, travel, the costs incident to meetings and by curtailment of general printing, purchase of supplies and equipment. In 1933 total expenditures averaged $20.86 per member as against $12.98 income from dues per member.

Despite the reductions in general administrative expenses during the depression period the activities of the Society were expanded rather than decreased. In 1929, a new department designed to provide assistance to committees, Divisions, Local Sections, and Student Chapters was established, and this continued to function throughout the lean years. Again, in 1935, another new department—that of Field Secretary—was added. The increase in these activities is demonstrated by the following:

In 1925 there were	20 functional committees;	in 1937,	24
In 1925 there were	8 Technical Divisions;	in 1937,	11
In 1925 there were	45 Local Sections;	in 1937,	61
In 1925 there were	76 Student Chapters;	in 1937,	115
Total in 1925	149	Total in 1937	211

GENERAL SERVICE TO MEMBERS

General service to members may be divided into three classifications, as follows: (1) Support of Local Sections; (2) "Self-improvement"; and (3) "Altruistic services." Item 1 needs no explanation. Item 3 refers to contributions in support of the Engineering

Societies Library, American Standards Association, Summer School for Engineering Teachers (1930), Engineers' Council for Professional Development (1936 and 1937), National Council of State Boards of Engineering Examiners (1937), the Reading Room, and Student Chapters.

General service which may be thought of as "self-improvement" looks toward the economic improvement of the members of the profession. Prior to 1929 the only expenditure in this category was the annual contribution of $1,815 to the joint Engineering Societies Employment Service. Then, in 1929, the Society joined American Engineering Council. In 1930 six professional committees were instituted and supported—namely, the committees on Engineering Education, Legislation, Public Information, Registration, Fees, and Salaries. In 1932 the Society joined the Construction League of the United States, and in 1936 a staff department on publicity was assembled. Thus expenditures for this form of service to members have increased steadily (except in the depression years, when contributions to American Engineering Council were materially diminished).

As might be expected, contributions to the support of the Employment Service increased materially in the depression years. At the same time many operations of the staff directed specifically toward reemployment, were undertaken, but neither their direct nor indirect costs have been segregated in this study. Among these operations may be mentioned the conferences held in Washington with federal administrators; the collection of biographical records of unemployed members and the transmission of same to federal authorities; the staff services contributed to the placing of unemployed members; the survey of the engineering profession; and the work of the Engineers' Council for Professional Development.

Technical Publications

In 1925 technical literature received by members consisted of 10 issues of Proceedings (which then contained "Society Affairs"), and the annual volume of Transactions. In 1937 the 10 issues of Proceedings were devoted wholly to technical papers and discussions. Transactions was practically unchanged. But in addition to these publications, 12 issues of Civil Engineering, and a number of Manuals and "Separates" went to every member.

Throughout the period under consideration two efforts have been dominant in the development of the technical publications: first, reduction in production costs; and second, application of the economies thus effected to increasing the volume, clarifying the presentation, and diversifying the character of the publications. The successive annual reports show tables of comparative figures in regard to publications which merit detailed consideration, but a few excerpts from the reports of 1925 and 1937 will perhaps be sufficient here to help in an appraisal of the economies that have been effected.

In 1925, the cost of illustrations in Proceedings and Transactions was $0.122 per thousand pages and the total production cost per page was $0.91. In 1937, illustrations cost $0.068 per thousand pages and the total cost of production was $0.70 per page, a saving of 25.6 per cent. In 1925, Transactions and Proceedings pages totaled 51,871,000 as compared with 60,680,000 pages in 1937. Bids are taken every three years and contracts placed accordingly. Printing contracts made in 1937 are on lower terms than those in force in 1936. Similar figures for Civil Engineering show in 1937 an 18.5 per cent decrease in cost since its first issues in 1930, notwithstanding the fact that its volume in 1937 was the greatest in the seven years of its existence.

Financial Condition of the Society

The ability of the Society to render service at the rate of $1.68, or even $1.71 as in 1931, for each $1.00 of dues collected, is due to its sound financial administration. In 1925, the Society had securities with a book value of $72,007.25 and cash amounting to $50,689.30—a total of quick assets, unencumbered, of $122,696.55. However, its property was mortgaged for $200,000. At the end of 1937, this mortgage had been paid off; $2,500 had been added to the investment in the 39th Street property; $124,868 had been set aside as a reserve, known as the "57th Street PropertyFund"; and fluid assets consisting of securities and cash totaled $76,345. Thus, its condition had improved by $281,016 in the 13-year interval. In addition, $34,650 had been paid as interest on the mortgage.

The Society is now clear of debt of any kind. Its fluid financial condition has improved by more than $280,000, notwithstanding the cancellation of dues of distressed members to the extent of over $213,000. The Society's investments return to it approximately $70,000 a year, a sum equal to $4.58 per member; and in 1937 there was income from the sale of publications and from advertisements, etc., equal to $4.72 per member. Membership has increased 38 per cent. Dues paid by the "average" member were 20 per cent lower in 1937 than in 1925. The Society's work has been expanded by the addition of three new staff departments, and several new undertakings have been initiated. Proceedings and Transactions have been produced at decreased costs; Manuals and Separates have been instituted; and Civil Engineering, a wholly new publication, has been given to the membership and developed well toward a self-supporting basis.

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Twenty-Five Old Friends

Periodically it is of interest to scan the records for the names of those who have been affiliated with the Society for the longest time. Here are the ranking 25—and it will be noted that even the youngest in this list will soon round out their fifty-second year of membership, while the two at the head have 62 full years of Society affiliation behind them:

Name	Date of Election
Francis, Henry Newton	March 1, 1876
Billin, Charles Emery	April 5, 1876
Gunnell, William Covington	February 7, 1877
Allen, C. Frank	February 6, 1878
Roberts, Percival, Jr.	May 7, 1879
Simpson, George Hume	October 6, 1880
Ferguson, John William	January 5, 1881
Doane, Walter A.	September 7, 1881
Thackray, George Edward	September 6, 1882
Willson, Frederick Newton	September 5, 1883
Juengst, Henry Frederick	April 2, 1884
Goldmark, Henry	May 7, 1884
Breithaupt, William Henry	June 4, 1884
Russell, Silas Bent	June 4, 1884
Flad, Edward	January 7, 1885
Kittredge, George Watson	January 6, 1886
Purdon, Charles De La Cherois	March 3, 1886
Barlow, John Quincy	April 7, 1886
Tratman, Edward Ernest Russell	April 7, 1886
Atwater, Almon Byron	May 5, 1886
Seaman, Henry B.	June 2, 1886
Abbott, Edward Lorenzo	September 1, 1886
Briggs, Josiah Ackerman	September 1, 1886
Rowland, Thomas Fitch, Jr.	September 1, 1886
Waddell, Montgomery	September 1, 1886

Mr. Seaman, twenty-first on the list, has the added distinction of being the senior living former Director of the Society. He was on the Board from 1900 to 1902.

ANNUAL CONVENTION of the Society, Salt Lake City, Utah, July 20–22, 1938

Soil Mechanics and Foundations Division Active

A Report to the Membership of the Division by Its Executive Committee

THE FOLLOWING report presents briefly the activities of the Soil Mechanics and Foundations Division since its organization in the fall of 1936, as well as its plans for the future. Suggestions and contributions by the membership of the Division, and constructive criticisms of past and contemplated activities, are earnestly sought by its executive committee:

The Committee on Bearing Value of Pile Foundations, under the chairmanship of H. A. Mohr, is a joint committee under the sponsorship of the Waterways Division. It has been very active in the preparation of a report which it hopes may become a Society manual. As soon as the report is completed it will be submitted to the executive committees of the contributing Divisions for their approval, prior to submission to the Committee on Publications of the Society.

The Committee to Cooperate with the A.S.T.M. Committee D-18 on Soils for Engineering Purposes has been inactive, as so far there has been no request for, or opportunity of, cooperation with the A.S.T.M. This committee is now under the chairmanship of R. V. Labarre of Los Angeles.

The Committeee on Foundations, under the chairmanship of Lazarus White, has actively continued the work of the former Research Committee on Earths and Foundations. It is studying the settlement of building foundations both in this country and in Europe and has given considerable thought to the problems of earth pressures in excavations. Financial assistance extended to this committee by the Engineering Foundation has been of material value in encouraging research work at Harvard, Yale, Princeton, and other universities and colleges.

The Committee on Glossary of Terms and Soil Classification, under the chairmanship of Prof. William P. Kimball, has concentrated its efforts to date on the establishment of a glossary, as a necessary forerunner to its other assignment. Questionnaires have been sent throughout the world in an effort to develop a glossary that will have general support. The extreme care which Professor Kimball is taking should assure an authoritative work. It should be completed during the present calendar year, after which the committee will immediately proceed with the larger task of soil classification.

The Committee on Sampling and Testing, under the chairmanship of Joel D. Justin, has set up an ambitious program. In the application of rational design methods to soil and foundation problems, it is necessary to obtain samples of materials and to test them in order to determine their strength for design purposes. After analyzing its problems, this committee has reached the conclusion that the development of the technique of sampling is the first requisite. The assistance of the Engineering Foundation was secured and with funds made available by it, Dr. Juul Hvorslev has been engaged as research engineer for the committee. Dr. Hvorslev is making his headquarters at Harvard University and will contact engineers active in this field with a view to securing their cooperation in his research. The members of the Division can be of material assistance if they will cooperate with him upon request and if they will communicate to him their experiences in obtaining undisturbed samples.

The Committee on Seepage and Erosion has carried on studies at the University of Minnesota dealing with the problems of seepage and piping. It is now under the chairmanship of Prof. Glennon Gilboy, and its research program has been financed by the Engineering Foundation.

The Committee on Bibliography, under the chairmanship of William P. Creager, is seeking to establish a bibliography of books and publications recommended for study to obtain a working knowledge of the subject of soil mechanics. It is the intention of the executive committee that this bibliography shall be a guide of real value to the profession. In carrying out its work, the committee is securing the cooperation of an advisory board of 23 American and 7 foreign engineers.

The 1938 Year Book of the Society lists two committees of the Division, formed within the past year. The first is that on Earth Dams and Embankments, under the chairmanship of L. F. Harza, which is working towards improvements in design methods of earth dams and seeking to encourage research in this field. In the great reclamation, power, and flood control projects that have been developed in the last few years, and in the expansion of water works facilities, it is becoming more and more apparent that earth dams must be relied upon to a large extent in reservoir construction. Only in recent years has the design of earth dams been anything but empirical. Recently, however, engineers have begun to analyze the stability of earth dams by the rational methods of soil mechanics. Admittedly, these analyses are at best but guides to experienced judgment. Because of the multiplicity of the problems involved, the committee is a large one and is divided into several subcommittees—namely, those on Piping and Drainage; Consolidation of Embankment and Foundation Materials, Cores, Cut-offs, and Impermeazation; Structural Design of Embankments and Foundations; and Stabilization and Protection of Embankment Slopes. In all, there are 28 members, including Professor Terzaghi as associate chairman. Some assistance has already been secured from the Engineering Foundation. One of the first objectives will be to set up a procedure for coordinating theoretical design and field results.

The second new committee is that on Cooperation with European Activities in Soil Mechanics Research, under the chairmanship of Prof. Charles Terzaghi in Vienna. It is too recently appointed to permit a report at this time, but its value and opportunities are evident.

The first technical session of the Division was held in connection with the 1937 Fall Meeting of the Society in Boston, under the general chairmanship of Frank A. Marston. In anticipation of this meeting, a symposium on "Soil Mechanics" was presented in the September 1937 PROCEEDINGS. The Boston program included papers on (1) the design of the proposed rock-filled dams of the now abandoned Passamaquoddy project, (2) the application of soil mechanics to the design of levees on the Mississippi River flood control projects, (3) the design of building foundations, and (4) recent developments in soil mechanics. An open discussion was also held on soil sampling methods. The attendance of over three hundred crowded to capacity the largest meeting room available.

Earlier in 1937 (May 22), a meeting of the Division was held on the Pacific Coast in conjunction with a meeting of the Los Angeles Section. A turnout of some two hundred engineers listened to a series of interesting papers at this session.

These meetings and the PROCEEDINGS symposium represent the tangible accomplishments of the Division to date. Perhaps, however, the most valuable work is being accomplished by the various committees, whose forthcoming contributions to the development of soil mechanics should meet a long-felt need.

The Division's Executive Committee desires to express its appreciation of the interest which has been taken in the work of the Division by the membership of the Society. It hopes that the members will give freely such cooperative assistance as may be requested by the various committees of the Division. It further desires to express its appreciation of the assistance rendered by the Engineering Foundation and by the membership of the Division's committees.

T. T. KNAPPEN, M. Am. Soc. C.E.
Secretary, Soil Mechanics and
Foundations Division

Pittsburgh Section Honors George S. Davison

A TESTIMONIAL dinner to George S. Davison, Past-President and Honorary Member of the Society, was tendered by the Pittsburgh Section on March 31, 1938, in the William Penn Hotel. Over a hundred and fifty of Mr. Davison's friends and associates gathered to do him honor.

R. P. Forsberg, president of the Pittsburgh Section, presided at the dinner, and Thomas Watson, of the Hillman Coal and Coke Company, was toastmaster. George T. Seabury, and R. P. Davis brought greetings from the Society, emphasizing the important contributions Mr. Davison had made to it and his unusual ability and tactfulness in directing its affairs.

W. C. Hawley, a graduate of Rensselaer Polytechnic Institute next told of the keen interest Mr. Davison had always taken in his school, particularly in the erection of the Pittsburgh Building, and also in service as trustee and chairman of various committees, and as organizer of the Pittsburgh Alumni Association. On behalf of Rensselaer, Mr. Hawley presented Mr. Davison with a scroll as a token of esteem.

The final testimonial was given by E. K. Morse, an associate in many of Mr. Davison's civic accomplishments. He emphasized the many years of service the guest of honor had given to Pittsburgh, Allegheny County, and the state of Pennsylvania. "Mr. Davison," he said, "never hesitated to give of his time to the community even though, with his many executive responsibilities, it meant a personal sacrifice."

In replying to the addresses, Mr. Davison chose as his subject "Lest We Forget." He recounted many interesting incidents in his early career and in those of his friends and associates.

The Civil Engineering Student and the Society

By Enoch R. Needles, M. Am. Soc. C.E.
Consulting Engineer, New York, N.Y.

The following address was delivered by Mr. Needles before a regular meeting of the Metropolitan Section of the Society, at which the Section had as its guests members of the eight Student Chapters in the New York metropolitan area. It merits the attention of every Student Chapter member—and particularly those who in another month will be taking up the practice of their profession.

I am pleased and honored to speak to those members of our Student Chapters who are here tonight. Your presence indicates your deep interest in your future profession, and shows that you are becoming professionally minded, even as students. The older engineers can assure you that they are proud and happy in the traditions and accomplishments of their profession and in their individual labors. We are proud to be called engineers; and we know you will be.

This year the American Society of Civil Engineers is eighty-five years old. It was founded as a technical society, and it has held steadfast to that designation and function. The development of our profession and the growth of our Society have been parallel and interwoven. Our Society has prospered in numbers, wealth, accomplishments, and service to its members. It is stronger and more prosperous now than ever before.

As the years have passed, our Society has worked consistently and in dignified and effective manner to strengthen the engineering profession, and to improve its status in the eyes of the public. Our Society has long sponsored and supported legislation in behalf of the engineer. It endeavors to assist in providing employment for its members. It has sponsored the providing of support for needy engineers, the development of many projects to provide engineering positions for the unemployed, and the securing of more nearly adequate salaries and fees for the members of our profession. Just now a comprehensive schedule of suitable salaries is being completed which should serve most effectively as a yardstick in salary discussions. Our Society has worked for improved educational facilities for engineers. Above all, our Society has encouraged and stood for the highest ethics in the practice of engineering.

On many occasions and for many years, efforts have been made to bring our Society into politics, or to have our Society function in behalf of special interests or groups. At times there have appeared real reasons why we should enter the fields of politics or the humanities. The pressure and the temptations to enter these fields have always been resisted, and the efforts have failed. It appears to me that they must always fail.

Ours is fundamentally a technical society. It serves both the Democrat and the Republican, the rich and the poor, the employee and the employer, the public servant and the private servant, the young and the old, the designer and the builder. Our Society knows no class distinctions. Let us be thankful that ours is a conservative and dignified Society that is founded on sound and enduring principles which will enable it to stand permanently.

The technical publications of our Society are of the highest quality and character, and they are manifold. Our technical committees and their accomplishments since the founding of the Society are notable beyond question. Their contributions to the profession of civil engineering are monumental. Our Local Section activities have grown and broadened to bring the Society closer to its members, and to permit individual activities and social contacts between engineers. In many ways, the inherent and unquestioned strength of our Society is that which comes from the multitude of its members who have labored and served on technical committees and in Local Sections, and who have contributed to making our publications what they are.

The standards for membership in our Society are of the highest. Integrity and decency are prerequisites to judgment of our status as accomplished engineers by our fellows for purpose of membership. The proudest claim of the civil engineer is that of membership in our Society, and we must enable him always to hold fast to that just pride which comes from membership in our select group.

I recite these facts because it is a healthy thing for us to reflect occasionally and to evaluate again our endeavors. You are the prospective leaders of our Society. Be active in your Student Chapter and make it strong and active, as you wish our Society to be. As a graduate, enroll as a Junior of the Society and participate in all activities of the Junior groups or forums which may be available to you. Join your Local Section and continue your endeavors towards the time when you will attain full membership in the Society. This program will afford you a satisfying measure of your progress in your profession.

I have often wondered which is the more envious of the other—the young engineer, who is ambitious and restless because of his slow progress towards becoming a recognized engineer, who wonders if a full beard will help him in securing respect for his ideas and opinions, and who can scarcely wait for the years to pass so he may attain the experience and the responsibilities of the engineer older than he; or the older engineer, who has lived a good part of his life and has attained some standing in his profession, but who looks back to some of his mistakes and failures to realize on his opportunities, and who wishes he could do some of his jobs over again with an educational preparation such as is commonly available to the student today.

Well, this simply proves again that we cannot have everything We can only do our best with what we have. It is an excellent thing for the younger and the older engineers to get together as we are tonight, so that the one may leaven, inspire, and enrich the other. I wish the student of today the greatest possible happiness and success in the future practice of engineering; and I am sure you will be helped if you look upon your education primarily as providing equipment and opportunity for you in your future professional service.

Arthur E. Morgan

Resolution Adopted by Board of Direction at Jacksonville, Fla., April 19, 1938

Whereas, Arthur E. Morgan as Chairman of the Tennessee Valley Authority requested a thorough investigation of that Authority by the Congress; and

Whereas, Arthur E. Morgan is acknowledged, both within the United States and abroad, as a civil engineer of outstanding ability; and

Whereas, Arthur E. Morgan, having been a member of this Society for twenty-eight years and having served as one of its Vice-Presidents, is known intimately by hundreds of its members; and

Whereas, the Board of Direction of the American Society of Civil Engineers, a Society composed of nearly 16,000 of the recognized leaders of the profession, is holding its regular meeting this 19th day of April, 1938, at Jacksonville, Florida;

Therefore Be It Resolved, that this Board, holding the firm belief that it truly represents the opinion of the entire civil engineering profession, hereby declares its highest respect for the personal integrity of Arthur E. Morgan; and

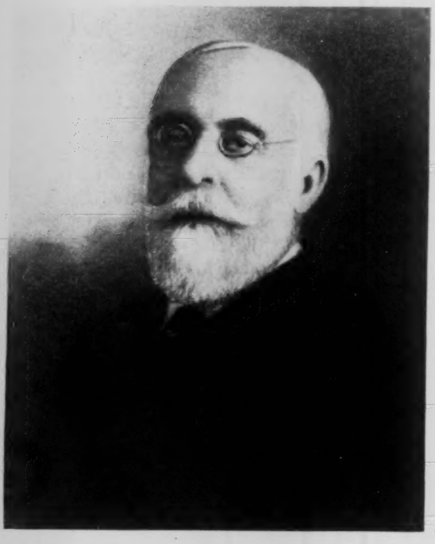
Be It Further Resolved, that this Board urges upon the Congressional Investigating Committee, which Mr. Morgan requested and which Congress has established, that it make a thorough investigation of such matters as he may wish to place before it and that it give full publicity to all its proceedings.

Early Presidents of the Society

XXVI. THOMAS CURTIS CLARKE, 1827–1901

President of the Society, 1896

"ENGINEERING is the great creative science. It has created a new nature governed by Nature's laws, but one which would soon disappear without the support of the engineer. Just as art creates new bodies of men and women, fairer than those of Nature, and literature creates new characters, as alive and real as the people we meet in the street, so does engineering create its new world."



THOMAS CURTIS CLARKE
Twenty-Sixth President of the Society

Thus Thomas Curtis Clarke, in his presidential address before the Society, pictured his chosen profession. For thirty years his own part in its continuous creation of a new world had been the building of bridges. His was the first iron bridge across the Mississippi; his the first American-built bridge on foreign soil; his the highest viaduct in the world.

Clarke, of Colonial ancestry, was born on September 5, 1827, in Newton, Mass. He received his formal education at the Boston Latin School and at Harvard University, from which he was graduated in 1848. His tastes were literary—as witness his officiating as class poet at the graduation—and he had intended to study for the law. However, on account of his delicate health he at length decided to adopt the profession of civil engineering instead. (The same change was made for the same reason, it will be recalled, by two other early Presidents of the Society.)

His first employment was on railroad location work in Alabama. An attack of fever forced him to return to Boston within a year, and there he took advantage of his enforced vacation to study architecture and mechanical drawing in the office of E. C. Cabot.

There followed 16 years of miscellaneous experience, mostly in Canada. He served as resident engineer on the Great Western Railway; was in charge of the government survey of 1859 for the improvement of the Ottawa River; erected two government buildings at Ottawa; and in partnership with another engineer leased the Port Hope and Peterboro Railway and operated it for some time as a private enterprise.

In the fall of 1866 Clarke was engaged to build a bridge over the Mississippi River at Quincy, Ill., for the Chicago, Burlington, and Quincy Railway. It was to be a low-level crossing with a pivot draw, and the first iron bridge across that river. The foundations presented many difficulties, and it was decided to do them by hired labor rather than contract, in order to keep the work more completely under the engineer's control. (Moreover, Clarke wrote, there were so few contractors prepared to furnish equipment for a job of that size, that, had they advertised it, there would have been but little competition.)

Unlike the Eads bridge, which was completed a few years later at St. Louis, the Quincy structure did not require the use of air. However, divers were used to a considerable extent to direct the under-water work, as shown in Fig. 1. The foundations were planned throughout to avoid the necessity of cofferdamming and pumping, in order to expedite construction.

Clarke was one of the first American engineers to use concrete on a large scale, and the specifications for that material as used at Quincy are enlightening:

"This concrete shall consist of 2 cu yd of Quincy limestone, screened and broken so as to pass through a 2½-in. ring, 3½ bbl of Falls City (Louisville) hydraulic cement, fresh ground, and 3½ bbl coarse river sand.... It is to be mixed by putting the broken stone in a frame 6 ft by 9 ft by 1 ft high, spreading the sand on it and the cement on the sand, pouring on water from a garden watering pot, and turning the whole over until every stone is seen to be coated with mortar. It is then to be shoveled into a concrete box and lowered under water into position, and leveled by a diver."

Clarke's comments on the superstructure are also of interest as reflecting the then-current practices in bridge building. "The practice of letting bridges by the price alone," he wrote, "has been too prevalent in this country. The design, the quality, and quantity of material, the maximum load and strain caused by it, and the character of workmanship, have been too often left to the honesty and capability of the patentees and builders of various kinds of bridges; and it is certainly very creditable to them that so few failures of iron bridges have taken place." At Quincy "it was decided to follow another course, and the engineer was instructed to draw up general specifications, and solicit tenders from bridge builders of known ability, in conformity with these general specifications—leaving the general arrangement of the plan only open to the parties tendering." Clarke's specifications called for the fixed spans to be build of cast and wrought iron, the draw span of wrought iron only. A maximum live load of 2,500 lb per lin ft was to be provided for, and that, plus dead load, was not to cause "a tensile strain of over 10,000 lb per sq in. on ties and lower chords, or 7,500 lb on pins, or a compressive strain on upper chords or posts of which the factor of safety shall be less than five."

Under these specifications 13 tenders were received—"two of the Fink patent, one Bollman, two wrought-iron riveted lattice, three triangular, one double triangular or trellis, two quadrangular, and

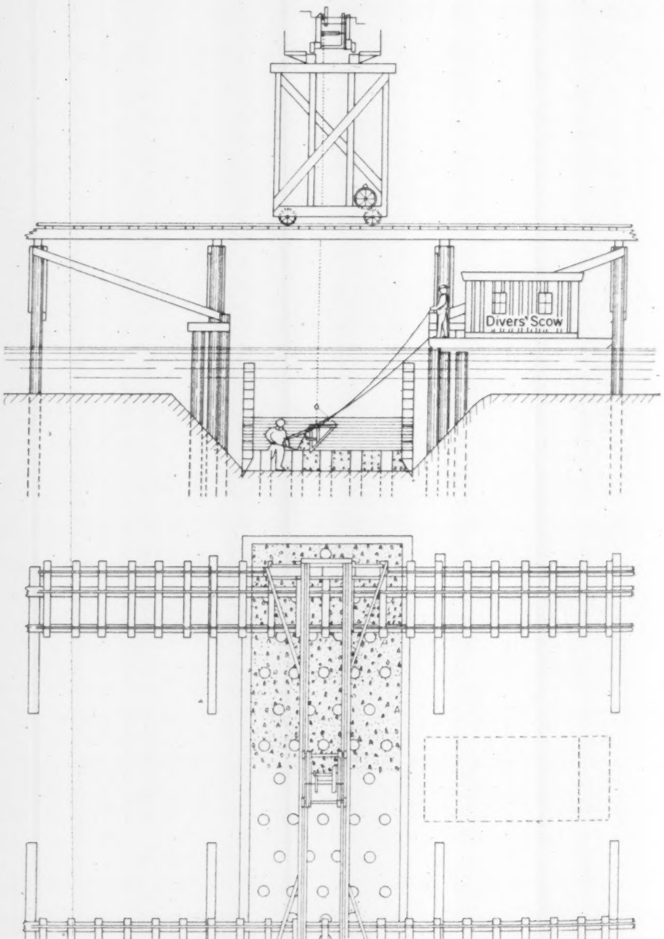


FIG. 1 CROSS-SECTION AND PLAN OF TYPICAL CRIB AT QUINCY BRIDGE, SHOWING CONCRETING IN PROGRESS
From a Book by Clarke Describing the Bridge

two of Post's quadrangular." The plan of the successful bidder called for "quadrangular girders, with cast-iron top chords; Phenix rolled posts; and bottom chords composed of open links with pin connections." The 18 spans were from 157 to 250 ft in length.

In 1870 Clarke formed a new firm in Philadelphia, called Clarke, Reeves, and Company. Clarke was the senior partner and his associates were Samuel Reeves, John Griffen, and Adolphus Bonzano, all Members of the Society. The firm became one of the leading bridge concerns of the United States, and constructed more than a hundred miles of bridges and viaducts, including the famous Kinzua Viaduct and a large part of the elevated railway system in New York City.

The Hawkesbury Bridge, New South Wales, Australia

The Kinzua structure, on the Erie Railway in McKean County, Pennsylvania, was, when built, the highest viaduct in the world—310 ft. It exceeded its nearest competitor (the Verugas Viaduct in Peru) by 60 ft. American engineers, it appears, had been prone to exercise more engineering skill "in avoiding the use of large bridges and viaducts...than could possibly have been shown in building them." Hence Kinzua attracted wide attention. (It was rebuilt in 1901.)

Engineering News in 1901 stated that Clarke shared with C. Shaler Smith, M. Am. Soc. C.E., "the credit of first designing the modern metallic viaduct with braced towers and connecting spans." However, J. E. Greiner, M. Am. Soc. C.E., in Transactions, 1891, was inclined to give him more than joint honors in that respect. "In 1869," he wrote, "Clarke designed a viaduct approach for the proposed bridge across Blackwell's Island, New York....Not wishing to use any perishable material like wood, the difficulty arising from changes of length due to changes in temperature was avoided by simply leaving out the longitudinal bracing and struts of each alternate bay, thereby giving a series of braced towers ..connected by girders...resting on their tops and having a sliding motion at one end. He...believes himself to be the originator of a well-known American Railroad Viaduct. This seems to be true, since, although Mr. C. S. Smith made application for letters patent on a similar general design in 1870, Mr. Clarke had anticipated him a whole year."

In 1884 Clarke became one of the original members of the Union Bridge Company in New York City. This firm built the Poughkeepsie Bridge over the Hudson River in 1888 and Hawkesbury River Bridge in New South Wales, Australia, in 1890.

The Poughkeepsie bridge provided a shortcut railway route between New England and the Pennsylvania coal fields, cutting the rail distance between Springfield and Scranton (formerly 305 miles) by 30 per cent. It consisted of three cantilever spans of 548 ft and two connecting spans of 525 ft and was erected in remarkably quick time. Falsework was used only in the erection of the anchorage trusses, the cantilevers being built out "uniformly from each side of the pier."

The Australian contract was taken in competition with the whole world, and was the first bridge to be built outside the United States by American engineers. *Engineering News* of January 5, 1889, stated that 14 designs were submitted to the examining board; three were American, nine English, one French, and one Australian. "The American bridges were all pin-connected and the foreign designs all riveted lattice...According to the report of the London Board of Engineers, recommending this award [to the Union Bridge Company], the plan of this company for the piers was the most engineering-like of any presented and promised the greatest measure of success, and upon this feature mainly the award was based." The plan was for a double-track steel railway bridge 2,896 ft long, divided into seven spans. (An interesting account of the erection of this bridge, by E. K. Morse, M. Am. Soc. C.E., junior partner of the contracting firm that erected the superstructure, is scheduled for a forthcoming issue of Civil Engineering. The picture shown here is from material supplied by Mr. Morse.)

After retiring from the Union Bridge Company, Clarke carried on a consulting practice in New York City, but devoted much of his time to travel. He was consulting engineer for the City of New York in building the Third Avenue and Willis Avenue bridges over the Harlem River, being responsible for both their design and their construction. These were his last works, and he died in New York City on June 15, 1901.

Clark was elected a member of the American Society of Civil Engineers on March 18, 1868, and a Fellow on May 20, 1872. He served as Director in 1879, as Vice-President in 1871, and as President in 1896. He also presented many papers and discussions at Society meetings.

He was a member of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Philosophical Society of Philadelphia, and one of the founders and a president of the Engineers Club of Philadelphia. He was one of the first American members of the Institution of Civil Engineers (London) and received the Telford Medal and Premium for a paper entitled "The Design Generally of Iron Bridges of Very Large Span for Railway Traffic" (1878).

In the Minutes of the Proceedings of the Institution, Sir Benjamin Baker wrote of him as follows:

"The death of my old friend Mr. Clarke will be sincerely lamented by many British engineers, for no one has done more than he to promote the cordial brotherly relationship which now happily exists between American and British engineers. It also severs one more link with the past, for Mr. Clarke's early experience with bridge building was in the days when there was hardly one point of resemblance between American and British wrought-iron bridges, the former being modeled after the type of the original timber-truss construction and the latter on that of the cast-iron shallow-girder system. Mr. Clarke sometimes said that he shuddered when he thought of some of his early bridges, with long slender cast-iron posts, slight lateral bracing, and totally inadequate pin-connections, even the floor girders being of the latter type, instead of the heavily-riveted low-stressed type which he lived to see substituted in all American bridge-work, as he also saw each country gradually introduce the good points of the other's practice, so that no vital difference now distinguishes European and American bridges."

In and About the Society

Attention is again called to the dead-line on applications for the Freeman scholarship, now being offered by the Society for hydraulic study abroad. As previously announced, applications must be on file by June 15, and it would be advisable to enter them as much before that date as possible. Full details on the conditions of the award will be furnished by Society Headquarters on request.

* * * *

The national character of the Society is reflected in its Headquarters personnel as well as in its membership. Someone with a statistical turn of mind has computed that the center of gravity of the universities represented by its administrative and editorial staffs falls roughly at Davenport, Iowa, while for the editorial group alone it is near Fort Wayne, Ind.

* * * *

Two prize-winning papers by members of last year's graduating class at Oregon State College have been filed for reference in the Engineering Societies Library: "Characteristics of Siphon Spillways" by Henry S. Burdin, Jr., and "Study of a Sharp-Crested Notch for Wide Variation of L/H Ratio" by William H. Edwards. Both authors were members of the Student Chapter at Oregon State Agricultural College, and are now Juniors, Am. Soc. C.E. The prizes were awarded by the Portland Section, together with one to Henry Wenderoth, whose paper on "Forecasting Rainfall by Mean Seasonal Distribution" was abstracted in the November 1937 issue of Civil Engineering.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

COUNCIL'S PROGRAM FOR 1938

THE management of the American Engineering Council has surveyed the field of its opportunities for 1938 and selected five groups of activities as being most likely to serve useful purposes among members of member organizations and the general public in the immediate future. A part of the program is already being translated into action.

I. Public Affairs Function

Serving through its staff and committees, as an interprofessional instrumentality for the presentation of the engineers' viewpoint on all phases of public affairs where engineering knowledge and experience are involved and the considered opinion of the engineering profession may be of public service, the American Engineering Council will:

1. Upon request, transmit engineering opinion and factual information to the federal government, including both legislative and administrative branches.
2. Make unbiased interpretations for the enginering profession of federal laws, rules, regulations, and practices and report them through its publications and releases.

II. Public Discussion Function

In cooperation with member societies, the American Engineering Council is initiating the practice of holding forums in which public problems related to engineering will be discussed by engineers for the purpose of clarifying and coordinating engineers' opinions. Initial forums are being arranged in Eastern cities. Experience with the earlier forums will determine the expansion of the public discussion function towards a broader consideration of public problems.

III. Engineers' Embassy Function

The staff of the American Engineering Council will continue to render as much service as possible under existing circumstances to member societies and their individual members on matters related to engineering arising from or connected with the federal government and its several branches.

IV. Publicity Function

The results of the functions outlined above are to be reported regularly to member organizations. In fact, within the limitations of funds, personnel, and facilities, the American Engineering Council is increasing the volume of its publications and endeavoring to improve their effectiveness. The schedule for 1938 includes:

1. A change in title, appearance, and editorial policy in Council's monthly publication.
2. A greater number of releases to member societies including their editors and boards of direction, and to the press regarding Council's activities and observations.
3. Use of annotated bibliography of articles expressing engineering opinion on matters of broad interest to engineers as an aid in integrating the work of AEC with all phases of related professional engineering opinion.

V. Fact-Finding Function

The functions referred to above have been selected from the many useful services which the American Engineering Council might perform. Several others should have consideration. Of such possibilities, the following have been selected for attention, if time permits, and if additional financing can be secured for such activities:

1. A fact-finding investigation of the situation surrounding employment of engineers and the relation to their employment of unionization and registration. In the meantime, Council will continue to actively support the merit system in public service under Civil Service, and in its conferences with government officials Council will endeavor to have them avoid unnecessary government competition with engineers in private practice.
2. A survey to determine the effect on employment of technology. As opportunities present themselves, Council will continue to crystallize public opinion of research, invention, and scientific investigation into appreciation of the true value of the broad field of technology as an entirely practical means for opening up new frontiers of employment and new sources of wealth essential to the attainment of that higher standard of living which has become generally accepted as the next major advance in our civilization.
3. A study of the relation of engineering to economics in public questions involving the capital goods, construction, extractive, and process industries in which engineers play the double role of being technically associated as employees and functionally related as managers of enterprises. The controlling factor is likely to be financing, but it is believed that influential members of member societies may be able to aid Council in interesting some of the foundations.

MANAGEMENT CONGRESS PLANS

The general sessions of the program for the Seventh International Management Congress to be held in Washington, September 19 to 23, 1938, are rapidly taking shape. Addresses will include management's difficulties with and responsibilities to government; the true relationship of "security" and "social control" to incentive and free enterprise; the social implications of the advancement of science; the case for labor, for management, and for the consuming public in the troubled interrelations of the three.

Speakers for these general sessions include Ralph E. Flanders, vice-president of American Engineering Council, who will speak on "The Balancing of Incentive and Social Security"; Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, who will discuss "The Influence of Technological Progress on Social Development."

Delegates to the congress will be presented with virtually a complete review of the best thought of the entire business and industrial world, upon every specific problem or aspect of management. A score of topics will be presented and discussed by the world's best authorities.

The congress is in the hands of an incorporated board of directors, of which William L. Batt, a member of the executive committee of American Engineering Council, is chairman.

ENGINEERS' COOPERATION WITH ARCHITECTS

Each chapter of the American Institute of Architects is being asked to invite all individual architects to cooperate with the Federal Housing Administration in a nation-wide campaign to revive the business of building residences. The program is intended to utilize the best available means for achieving a sustained long-term residential construction program with a minimum of expenditure of federal funds and a maximum reliance on private business enterprise.

Housing is more directly the field of the architect and the contractor, but engineers are related to it and may be interested in many ways. On the larger multi-family undertaking the architect needs engineers from start to finish; the engineer is essential to group housing projects from layout through construction; and the engineer, in many phases of industry, makes vast contributions towards the development and production of more useful and economical building equipment, materials, supplies, and appliances. The architects are, therefore, soliciting engineering cooperation with their efforts to aid government agencies in the stimulation of better housing facilities.

TRAIN LENGTH LEGISLATION AND RAILROAD DIFFICULTIES

Restrictive railroad bills (H.R. 2749) involving a six-hour day, (H.R. 69) prohibition of more than 70 cars in a freight train, and (J.R. 2022) inflexibly large crews regardless of actual needs, have been before Congress since 1936. The American Institute of Consulting Engineers has filed protestations and has asked the American Engineering Council to follow the course of such legislation, but no other engineering organization has expressed a point of view to Council. Council has therefore confined its activities to making representations for A.I.C.E.

Without engaging in lobbying tactics, Council has maintained the point of view that the enactment of such legislation would be against the interests of the public safety as well as railway employees, and that it would place an added financial burden upon the railroads and the shipping public. No more hearings are scheduled and there will not be much more that can be done about these particular bills, but Council would like to have the opinion of its member societies on such legislation for staff guidance.

Activities of the Federal Government Involving Engineering

Acting Chairman Clyde L. Seavey of the Federal Power Commission announced April 1, 1938, that: "Responding to the request of Mayor W. J. Hammond and City Manager D. L. Lewis, the Federal Power Commission has consented to make a preliminary estimate of cost for an electric distribution system for the City of Fort Worth, Tex., and a forecast of the power requirements of that city during the next decade."

That action seemed to be more the result of the following telegram from Mr. A. J. Wirtz, general counsel of the Lower Colorado River Authority at Austin, Tex., than from the request of the officials of the City of Fort Worth, Tex.: "Am advised Fort Worth has requested your commission to make power survey of city. Inasmuch as Lower Colorado River Authority has been negotiating with city for sale of power, we trust the commission may see fit to comply with the request and make information available to the Authority."

Mr. Seavey's announcement stated that "the proposed survey does not contemplate appraisal and valuation of the privately owned electric facilities now serving the city, but an engineering estimate of the cost of constructing a new distribution system capable of serving the entire city at the present time and for some years in the future."

Since the announced intention of the Federal Power Commission indicated federal government competition with engineers in private practice against the general public welfare, the staff of the American Engineering Council in response to a number of inquiries, contacted the Federal Power Commission and was invited to discuss the situation with Mr. Seavey. The latter assured Council that the Federal Power Commission has "no intention of engaging in any business or professional activity in competition with private industry or with engineers in private practice."

Mr. Seavey explained that under the federal statutes creating and expanding the Federal Power Commission, the commission is charged with special duties in connection with the activities of federal government agencies engaged in the generation and distribution of power in the form of elective energy. "Special studies and surveys affecting the electric industry and the public are conducted by the commission, reports on which are submitted to the President and to the Congress." In other words the Federal Power Commission is under legal and "executive orders" to assist agencies of the federal government or those financed with federal funds with the consummation of their objectives.

In this instance, Mr. Seavey says that the commission has responded directly to the request of the Lower Colorado River Authority, in conformity to federal statute; and only indirectly to the municipality of Fort Worth, Tex. The commission considers the service it may render Fort Worth, as a city, incidental to a market survey which they are making for the Lower Colorado River Authority. The study, survey, or estimate at Fort Worth is supposed to show the immediate and future market for electric energy, in and around that city; and to indicate the probable cost of providing an adequate distribution system either by purchase of existing privately owned facilities or by construction of a new publicly owned distribution system.

Forecast for May "Proceedings"

Water-Softening Plant Design

by W. H. Knox. M. Am. Soc. C.E.

Outlines the status of the art with valuable detailed advice to engineers engaged in this type of work.

Observed Effects of Geometric Distortion in Hydraulic Models

by Kenneth D. Nichols, Jun. Am. Soc. C.E.

Experience with models at the Waterways Experiment Station, Vicksburg, Miss., with conclusions supported by other laboratories in the United States and Europe.

A Theory of Silt Transportation

by W. M. Griffith, Esq.

Presents a useful method for designing stable channel sections and for studying the effects of river control works on depths of flow. In the April forecast, this paper was scheduled to appear in the April "Proceedings." Due to unavoidable circumstances, publication was postponed to May.

Aerodynamics of the Perisphere and Trylon at the New York World's Fair

by Messrs. Alexander Klemin, E. B. Scaefer, and J. G. Beerer

A model study of what happens when a tower interferes with wind pressure on a spherical building.

American Engineering Council approached the Federal Power Commission in its usual spirit of helpfulness to all branches of the federal government and offered to provide the commission with united engineering opinion in all instances where the use of professional engineering services may be involved and give the commissioners and their associates the benefit of unbiased engineering knowledge and experience as long as problems under consideration do not call for the professional services of an engineer or engineers in private practice.

The commission has expressed appreciation for the interest shown by Council in its activities, and for the offer of assistance. Mr. Seavey has invited Council to contact him at any time on behalf of engineers and in the public welfare. In doing so, he reiterated that it is not the policy of the commission to engage in any form of competition with private enterprise or to serve political subdivisions in competition with engineers or others in private professional practice.

Council's First Forum

Representatives of engineering, industry, economics, and finance will discuss ways in which employment can be increased and business aided, at the first public forum sponsored by American Engineering Council, to be held on Friday, May 13, at the clubhouse of the Engineers Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa. This is the first of a series of regional meetings to be sponsored by the Public Affairs Committee of the American Engineering Council to forward a wider public understanding of the interrelation between engineering and the vexing social and economic questions of the day.

At the afternoon session there will be two speakers—one an economist and one an industrialist. Dr. Leo Wolman, a member of the staff of the National Bureau of Economic Research, professor of economics, Columbia University, and former chairman, Labor Advisory Board, NRA, will discuss the interrelation between wages, machinery, and social security. Leonard J. Fletcher, Assistant General Sales Manager of the Caterpillar Tractor Company, and a member of the Committee on Engineering Economics of American Engineering Council, will then present some of the conclusions reached by that committee in regard to the Balancing of Economic Forces. Each address will be followed by prepared and general discussion.

The same arrangement will be followed at the evening session, with one economist and one industrialist as the speakers. They are, respectively, Dr. Alexander Sachs, Economist and Director of Research, The Lehman Corporation, New York ("Engineers, Economists, and Politicians"), and William J. Kelly, president of the Machinery and Allied Products Institute, and president of Arthur J. O'Leary and Sons ("Relation of Technology to Finance").

The proceedings of this forum will be reproduced for a limited distribution to engineers, engineering and allied technical organizations, educational institutions, interested private enterprise, and to officials of the federal government and its several branches. The meeting will be open to the public and to all divisions of the press. All members of the engineering organizations in the city and neighboring states and cities are invited to attend, as well as the public at large. There is no charge except for lunch and dinner, which will be served at the Club at modest prices.

Washington, D.C.
April 15, 1938

Minutes of March Society Meeting

As previously announced, a meeting of the Society was called for March 16, 1938, at Headquarters for the purpose of canvassing ballots on a proposed amendment to the Constitution of the Society, Article VII—Nomination and Election of Officers. It was found that this business meeting could not be held at that time because there was not the required quorum of thirty Corporate Members present. The meeting was therefore recessed until March 23, 1938, to which date the meeting of the Metropolitan Section had also been postponed.

On Wednesday evening, March 23, in the Engineering Societies Building, the Society meeting was called to order by Vice-President Malcolm Pirnie, who appointed the following members as a committee of tellers to conduct the canvass of ballots: Charles W. Comstock, Chairman, James A. Darling, A. A. Dedouloff, W. J. Delaney, Joseph Fertik, Thomas K. A. Hendrick, J. A. Lenecek, Medwin Matthews, and I. Thorner. Later in the evening, Chairman Comstock of the Tellers Committee reported on the result of the canvass of the ballots, as noted in full in the following item. There being no other business, the meeting was adjourned.

Report of Tellers on Constitutional Amendment Re "Nomination and Election of Officers"

March 23, 1938

To the Secretary
American Society of Civil Engineers

The tellers appointed to canvass the ballot on amendment to the Constitution report as follows:

Total number of ballots received		2,522
Ballots excluded from the canvass		
From members in arrears of dues	21	
Without signature	7	
With illegible signature	1	
From Non-Corporate member	1	
From non-member	1	
Total ballots not canvassed	31	
Ballots canvassed		2,491

Yes	460
No	2,026
Blank	1
Void	4
Total	2,491
Total votes counted (yes or no)	2,486
Required to carry	1,658
Lost by	1,198

Respectfully submitted,
Charles W. Comstock, *Chairman*

Wm. J. Delaney
James A. Darling
J. A. Lenecek
Irving B. Thorner
Joseph Fertik
A. A. Dedouloff
Thomas K. A. Hendrick
Medwin Matthews

Tellers

Appointments of Society Representatives

Henry E. Riggs, President Am. Soc. C.E.; Alonzo J. Hammond, Past-President Am. Soc. C.E.; John C. Hoyt and Carlton S Proctor, Members Am. Soc. C.E.; and George T. Seabury, Secretary Am. Soc. C.E., will serve as the Society's representatives on the Construction League of the United States

William Joshua Barney, M. Am. Soc. C.E., has accepted appointment as the Society's representative on the project of the American Standards Association on Standards for Safety in the Construction Industry.

News of Local Sections

Scheduled Meetings

Central Ohio Section—Dinner meeting with the Ohio State University Student Chapter at Pomerene Hall on May 18, at 6:30 p.m.

Cleveland Section—Annual joint dinner meeting with the Student Chapters of Ohio Northern University, Akron University, and Case School of Applied Science, on May 3.

Colorado Section—Dinner meeting at the University Club, Denver, on May 9, at 6:30 p.m.

Kansas State Section—Meeting at Topeka on May 13.

Los Angeles Section—Dinner meeting at the California Institute of Technology, Pasadena, Calif., on May 11, at 6:15 p.m.

Metropolitan Section—Meeting in the Engineering Societies Building, New York, on May 18, at 8 p.m.

Mid-South Section—Annual meeting at the Marion Hotel, Little Rock, Ark., on May 5 and 6 (postponed from April 29–30).

Philadelphia Section—Dinner and meeting at the Engineers Club on May 18, at 6 p.m. (meeting 7:30 p.m.).

Pittsburgh Section—Annual meeting at the William Penn Hotel on May 12, at 8 p.m.

Sacramento Section—Regular luncheon meetings at the Elks Club every Tuesday, at 12:10 p.m.

St. Louis Section—Luncheon meeting at the Mayfair Hotel on May 23, at 12:15 p.m.

San Diego Section—Regular meeting on May 26.

San Francisco Section—Meeting of Junior Forum on May 17.

Seattle Section—Dinner meeting at the Engineers Club on May 23, at 6:00 p.m.

Spokane Section—Luncheon meeting at the Davenport Hotel on May 20, at 12 m.

Syracuse Section—Annual dinner meeting on May 16.

Tacoma Section—Regular meeting on May 9.

Tennessee Valley Section—Dinner meeting of the Knoxville Sub-Section at the University of Tennessee Cafeteria on May 5, at 6:15 p.m.

Texas Section—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on May 2, at 12:15 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on May 14, at 12 m.

Recent Activities

Arizona Section

An informal dinner meeting of the Arizona Section was held on February 10. The speaker on this occasion was Raymond A. Hill, Director of the Society, who gave a résumé of the Annual Meeting of the Society. Henry E. Riggs, President of the Society, was the guest of honor at an informal dinner meeting, which took place in Phoenix on March 17. There were 20 present to hear Dr. Riggs discuss current Society problems. Members of the Section escorted Dr. Riggs to many points of engineering and scenic interest during his stay in the state. He also attended Arizona's First Annual Roads and Streets Conference, held at the University of Arizona in Tucson on March 18 and 19. About 200 were present at this conference, which was sponsored by the Arizona Section, the civil engineering department of the University of Arizona, and the Arizona State Highway Department. The list of speakers included Howard S. Reed, state highway engineer; W. G. O'Harra, W. R. Hutchins, F. N. Grant, E. V. Miller, and P. Jones, all connected with the State Highway Department; F. C. Kelton and E. S. Borgquist, of the civil engineering department at the University; and L. O. Fiscel and George T. Grove, county engineers.

Buffalo Section

On March 8 members of the Buffalo Section gathered at the Buffalo Athletic Club for a buffet supper meeting. The speaker was W. B. Rudd, who showed a film illustrating the operation of a car retarder freight yard. Mr. Rudd gave a running commentary as the film progressed and, later, answered many questions concerning the operation. The rest of the evening was devoted to cards, billiards, and conversation. There were 27 present.

Central Illinois Section

Discussion of grade-crossing problems was the feature of the March dinner meeting of the Central Illinois Section, which was held in Springfield on the 18th. The 38 members and guests present heard Alfred Benesch, engineer of grade separations of the Illinois State Division of Highways, discuss highway and railroad grade-crossing problems in the state. A colored motion picture illustrating the various types of grade-crossing protection described by Mr. Benesch was then shown through the courtesy of the Western Railroad Supply Company. Recently the Central Illinois Section passed a resolution urging the adoption of the Hayden-Ickes Plan for expediting the mapping of the United States. Copies of this resolution were sent to President Roosevelt and a number of other government officers.

Central Ohio Section

There were 27 present at the regular monthly meeting of the Central Ohio Section which took place at the Chittenden Hotel in Columbus on March 17. The speaker was John Fisher, director of the U. S. Weather Bureau in Columbus, who gave an instructive talk on the operation of the Bureau and weather forecastings. Mr. Fisher substituted for the scheduled speaker, Kirk M. Reid, of the General Electric Company, who was taken ill shortly before the meeting.

Cincinnati Section

A joint meeting of the Cincinnati Section and the Technical and Scientific Societies Council took place on February 18, with an attendance of 1,500. The meeting was preceded by a dinner for 66, at which C. E. Kilgour acted as toastmaster. Mayor J. G. Stewart and C. O. Sherrill, city manager of Cincinnati, were the after-dinner speakers. The speaker at the joint session was Miller McClintock, whose subject, "Traffic in the City of Tomorrow," elicited enthusiastic discussion. On March 29 a joint session with the University of Cincinnati Student Chapter was held in the Student Union Building. During the business meeting, the following new officers were elected: Warren W. Parks, president; William W. Carlton, vice-president; and R. W. Renn, secretary-treasurer. A discussion of Society affairs was given by J. E. Root, Director of the Society, and the report of the Student Prize Committee was heard. After a response by Richard J. VanVeen, president of the Student Chapter, the speaker was introduced. This was Colonel Sherrill, who gave an able talk on the place of the engineer in public service. The attendance numbered 70.

Dayton Section

The Dayton Section officially honored the Student Chapter at the University of Dayton with a dinner at the Engineers Club on March 21, the occasion being the recent selection of the Chapter as one of the twelve most active Student Chapters in the United States during the past year. After brief remarks by past and present officers of the Chapter, the principal speaker of the evening was introduced. This was Frank C. Tolles, consulting engineer of Cleveland, who discussed engineers' fees and salaries. The president of the University of Dayton was also present and made a brief address. The accompanying photograph shows Student Chapter members together with officers of the Section and the speakers. The attendance of 50 included Student Chapter members from Antioch College as well as the University of Dayton.

The Dayton Section Entertains the University of Dayton Student Chapter

Duluth Section

Luncheon meetings were enjoyed by the Duluth Section on January 17 and February 21. During the business session of the January meeting officers for 1938 were elected. These were listed in the March issue of Civil Engineering. The principal speaker at the February meeting was P. M. Reeve, of the U. S. Engineer Office, who discussed plans for national defense in case of war. He was followed by H. C. Walker, who presented a motion picture showing the manufacture, shipment, and use of precast reinforced concrete pipe. On March 23 a farewell dinner was given for Albert B. Jones, president of the Section. Major Jones, who was district engineer for the U. S. Engineer Office at Duluth, has been transferred to Washington, D. C., and R. M. Palmer has been elected to replace him as president of the Section. Following dinner the entertainment committee called on Ford Boyd to show a colored motion picture that he had made in Mexico.

Hawaii Section

On February 25 the Hawaii Section held a joint luncheon meeting with the Engineering Association of Hawaii in Honolulu. Henry E. Riggs, President of the Society, who has been visiting in Hawaii, addressed the group on the subject of "Relations Between Local and National Engineering Societies." Another visiting member of the Society, was James W. Rickey, consulting engineer for the Aluminum Company of America. The attendance numbered 48.

Illinois Section

The Juniors of the Illinois Section held meetings on February 28 and March 28. At the February meeting the speaker was Miles D. Catton, of the Portland Cement Association, who gave an illustrated talk on the properties of soil-cement mixtures, and their use in the building of low-cost roads. The 30 Juniors present asked many questions, which Mr. Catton answered. There were 29 present at the March meeting, which was attended by W. W. DeBerard, Director of the Society, and J. Gardner Bennett, president of the Illinois Section. The feature of the occasion was a talk by A. P. Haake, director of the National Association of Furniture Manufacturers, who spoke on "Labor Unions and Management."

Indiana Section

On March 18 the Indiana Section, in a joint meeting with local branches of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, sponsored a lecture by Loran D. Gayton, city engineer of Chicago. The talk, which was illustrated with colored lantern slides, dealt with crossings of the Chicago River from early Indian times to the present. The meeting, which was held in Indianapolis, was preceded by a dinner for members and guests, which was attended by 35. The attendance at the meeting numbered 65.

Ithaca Section

Following a dinner meeting of the Ithaca Section, which took place on March 14, there was a joint session of the Section and the Cornell University Student Chapter. The speaker was Charles C. Agar, principal assistant engineer of the New York State Department of Health, whose topic was "Sanitation in Flood Disasters." Mr. Agar related his experiences in floods in 1935 and 1937. There were 75 at the joint meeting and 14 at the dinner preceding it.

Kansas City (Mo.) Section

There were 35 present at a meeting of the Kansas City (Mo.) Section, which took place on February 10. After a business session H. A. Buehler, state geologist of Missouri, was introduced. Dr. Buehler discussed the mineral resources of the state, illustrating his talk with charts, lantern slides, and samples of material.

Los Angeles Section

The President of the Society and two Past-Presidents—Louis C. Hill and H. S. Crocker—were among the 133 members and guests present at the March meeting of the Los Angeles Section, which was held at the University Club on the 9th. Short talks on the recent flood in southern California were given by H. E. Hedger and Paul Baumann, assistant chief engineers of the Los Angeles County Flood Control District. Then Dr. Riggs discussed the growth and expansion of the Society over a period of years. He also reported that the membership of the Society has reached an all-time peak. He was followed by Fred J. Grumm, engineer of survey and plans for the California Highway Commission, who gave a résumé of the development of the California state highway system.

The Junior Forum of the Los Angeles Section met at the University Club preceding the dinner meeting of the Section. This group was addressed by one of their own members, F. Marian Andrus, who spoke on building code enforcement.

METROPOLITAN SECTION

"Railroad Electrification—Its Accomplishments and Outlook" was the subject of an illustrated paper presented at the March meeting of the Metropolitan Section, which took place in New York on the 23d. This was presented by Ernest R. Hill, consulting engineer of New York, who discussed the situation in several foreign countries as well as the United States. Considerable discussion followed Mr. Hill's talk, and a pleasant social hour concluded the meeting. There were 400 present.

On March 22 the Junior Branch of the Metropolitan Section held its regular meeting, which was addressed by B. H. Self, supervising engineer for the Travelers' Insurance Company. Mr. Self gave an interesting talk on safety in building construction. At a meeting held on April 13 Grant Hedrick, designer and detailer for Waddell and Hardesty, gave a talk entitled "A Demonstration of Photoelastic Analysis." To illustrate his remarks complete laboratory equipment was on hand and in operation.

MILWAUKEE SECTION

There were 29 present at a meeting of the Milwaukee Section, which was held at the City Club on March 14. During the business session L. D. Knapp was appointed temporary secretary because of the illness of F. W. Ullius. Several committees reported, and the subject of engineers' salaries was discussed. The speaker of the evening was E. M. Brevik, structural engineer for the Portland Cement Association, who gave an illustrated lecture on "Architectural Concrete Construction." An animated discussion of Mr. Brevik's talk concluded the evening.

NASHVILLE SECTION

On March 1 the Nashville Section held a meeting at Vanderbilt University, which was preceded by a dinner. After transacting routine business, the 21 members present heard Charles W. Hawkins speak. Mr. Hawkins, who is assistant engineer for the Nashville Planning and Zoning Commission, chose for his topic, "Transportation in the City of Nashville."

NEW MEXICO SECTION

President Riggs attended a joint meeting of the New Mexico Section and the University of New Mexico Student Chapter, which was held in Albuquerque on March 22. Following a business session Dr. Riggs spoke. Preceding the meeting, an informal dinner was given for Dr. Riggs at the Hotel Alvarado. This was attended by 26 members of the Section.

NORTHWESTERN SECTION

Numerous business matters were discussed at a meeting of the Northwestern Section that took place at the University of Minnesota on March 15. The feature of the occasion was an illustrated lecture on housing, giving by Robert Jones, of the school of architecture at the University of Minnesota. There were 22 present.

PANAMA SECTION

A meeting of the Panama Section was called to order on March 4, with 24 present. The technical program consisted of a talk by W. L. Douglas, former engineer of maintenance for the Panama Canal, whose subject was the history of changes in engineering knowledge. An enthusiastic discussion followed. Various matters of local interest were then considered.

PHILADELPHIA SECTION

Two addresses of outstanding interest provided an enjoyable evening for those who attended the March 16th meeting of the Philadelphia Section. The first speaker was C. S. Gleim, engineer of construction for the Port of New York Authority, who gave an illustrated lecture on the Lincoln Tunnel. He was followed on the program by Samuel I. Sacks, consulting engineer of Philadelphia, whose subject was "An Engineer's Impression of Europe and Palestine." Mr. Sacks also showed several reels of colored motion pictures that he had taken on a recent trip abroad. There were 75 members and guests at the meeting, and 35 at the dinner preceding it. Solomon M. Swaab, consulting engineer of Philadelphia, was the chairman.

PITTSBURGH SECTION

Junior members of the Pittsburgh Section held a special meeting on March 17, which was addressed by E. A. Holbrook, dean of the school of engineering of the University of Pittsburgh. Dean Holbrook spoke on the value of registration for professional engineers. After an interesting discussion from the floor the 30 present enjoyed light refreshments and a social hour. A regular meeting of the Section took place on March 25, with 68 present. The principal speaker on this occasion was A. G. Butler, manager of engineering construction for the Duquesne Light Company, who discussed the subject, "The Private Electric Power Industry." A report on the papers and discussions presented before the Power Division at the Annual Meeting of the Society was then given by J. P. Growden, chief hydraulic engineer for the Aluminum Company of America.

PORTLAND (ORE.) SECTION

A number of students from the Utah State Agricultural College Student Chapter were among the 80 present at the March 16 meeting of the Portland (Ore.) Section. The group was in Portland as guests of the Section while on their annual inspection trip. The feature of the technical program was an illustrated talk on "Research on Airplane Radio Interference," given by E. C. Starr, professor of electrical engineering at Oregon State College. Refreshments were enjoyed at the close of the meeting.

PROVIDENCE SECTION

On March 9 the Providence Section held a business meeting for the purpose of acquainting members with the provisions in a proposed Rhode Island law for the registration of professional engineers and land surveyors. The law, which closely follows the model law, was discussed and finally endorsed by the Section, and the secretary was instructed to notify the proper persons of such endorsement. There were 18 present.

SAN DIEGO SECTION

The San Diego Section has been holding its regular monthly meetings. On January 27 the speaker was B. F. Dupuy, engineer for the Tijuana Valley sewer project, who described the difficulties that were overcome in constructing this trunk sewer. At a meeting held on February 24, H. C. Morin, of the San Diego Chamber of Commerce, described the new 200-in. telescope soon to be installed on Palomar Mountain. The date of the March meeting was advanced to the 11th so that the Section might entertain President Riggs. In his talk Dr. Riggs gave an interesting summary of the history of the Society. The attendance at these sessions was 16, 17, and 16, respectively.

SPOKANE SECTION

A regular meeting of the Spokane Section took place at the Crescent Tea Room on March 11, with 12 present. This session was given over to the discussion of business matters. A motion was passed authorizing the secretary to notify Student Chapters at the University of Idaho, Washington State College, and Montana State College that prizes will again be offered to seniors for outstanding papers on engineering subjects.

TACOMA SECTION

Business discussion occupied part of the March 15th session of the Tacoma Section, which was attended by 26 members and 15 guests. Randolph Simpson, the first speaker on the technical program, presented a paper on "Steel and Steel Castings" and exhibited test specimens of various steels and alloys. He was followed by Alexander Finlayson, who discussed the subject, "The Endurance of Metals Under Repeated Stresses."

Tennessee Valley Section

The Chattanooga Sub-Section of the Tennessee Valley Section held a business meeting on February 23, with 19 present. Following the business session, a motion picture of Grand Coulee Dam was shown and discussed by Lee G. Warren, project engineer for the Tennessee Valley Authority. At a meeting held on March 24, there were 40 present to hear Allison White, of the Hamilton County Regional Planning Commission, discuss the proposed development of park and recreational facilities on the Chickamauga Reservoir.

On March 3 the Knoxville Sub-Section held a meeting, which was addressed by A. M. Komora, assistant construction engineer for the Tennessee Valley Authority. Mr. Komora discussed the "Performance Tests of Norris Turbines," illustrating his talk with lantern slides. There were 68 present. There was a meeting on April 7, which was addressed by Gerald Gimre, city planning engineer of Nashville.

The Muscle Shoals Sub-Section held its monthly meeting at Wilson Dam on March 10, with 11 present. The speaker was Mr. Komora, who discussed the Norris Dam turbines.

Toledo Section

There were 31 present at a meeting of the Toledo Section, held on April 8. The technical program consisted of two speakers—W. S. Housel, associate professor of civil engineering at the University of Michigan, and Leo V. Garrity, construction engineer for the city of Detroit. Both discussed the general subject, "Practical Application of Soil Mechanics, and both lectures were illustrated with slides and motion pictures. An enthusiatic discussion followed.

Student Chapter Notes

Missouri School of Mines and Metallurgy

On February 8 the Missouri School of Mines and Metallurgy showed the Society's lantern slide lecture on the Stevenson Creek Dam in conjunction with some films furnished by the Great Lakes Dredge and Dock Company. These films were enjoyed by a large number of Chapter members as well as several visitors.

Norwich University

About 25 members of the Norwich University Student Chapter were present for the showing of the Society's illustrated lecture on the Miami Flood Control Project on March 9. Another interesting feature of this occasion was a talk given by a member of the local weather bureau, who summarzied methods of collecting meteorological data and emphasized the significance of such data in the solution of various engineering problems. It was felt that the two lectures complemented each other very satisfactorily and gave a complete analysis of the problem of flood control.

Pennsylvania State College

On March 22 the Pennsylvania State College Student Chapter entertained L. F. Bellinger, Vice-President of the Society, at a banquet. This affair preceded a regular meeting of the Chapter, which was addressed by Mr. Bellinger on the subject of the versatility required of the civil engineer in the U. S. Navy. The list of 50 present included 15 faculty members. The speaker at the April 5th meeting of the Chapter was C. L. Harris, professor of architectural engineering at Pennsylvania State College. Professor Harris, whose subject was "Wind Stresses in Tall Buildings," has conducted his wind-pressure research in a large wind tunnel in Washington, D. C. The attendance was 51.

South Dakota State College

A meeting of the South Dakota State Student Chapter took place on February 2, with 21 present. After a short business session the Society's lantern slide lecture on Mississippi River flood control was presented by two Chapter members. Refreshments were served at the conclusion of the meeting.

Tulane University

The Tulane University Student Chapter reports that several inspection trips to places of engineering interest have been made during the past year. These trips have included visits to the site of the Charity Hospital during the construction of the foundations, and to the Tulane University stadium, an all-steel structure, which was completed in November. The accompanying photograph shows the group of students at the stadium. One member of the Chapter, Jack S. Burke, presented a technical paper at the annual convention of the Louisiana Engineering Society.

Group from Tulane University Student Chapter Visits New Stadium

University of Maine

There were 25 present at a meeting of the University of Maine Student Chapter held on March 17. The speaker of the evening was Earl F. Bennett, soils engineer for the Maine Highway Commission, who discussed the use of dynamite in the settlement of deep fills. Motion pictures, illustrating actual field practice in settling fills in swamps at Mattawamkeag and Bath, Me., were shown. Of unusual interest were the slow motion pictures depicting the actual explosions of dynamite and clearly indicating the slight lifting effect of the artificial fill.

University of Vermont

The University of Vermont Student Chapter has been active in sponsoring events of professional interest. On March 4 Nord Davis, an engineer connected with the Burlington, Vt., zoning work, addressed the regular monthly meeting of the Chapter on the subject of "Zoning in Its Relation to City Planning." On March 18 the Chapter was joint sponsor, with the Robert Hull Fleming Museum, of an illustrated lecture on covered bridges. This lecture was presented by Louis B. Puffer, professor of civil engineering at the University of Vermont, who has an interesting collection of photographs of old covered bridges.

University of Wisconsin

On March 24 members of the University of Wisconsin Student Chapter enjoyed the Society's illustrated lecture on Mississippi River flood control, which was presented by James G. Woodburn, professor of hydraulic engineering at the University. There were 30 present.

Utah State Agricultural College

The Utah State College Student Chapter reports that there has been wide interest in the Society's illustrated lectures. Evidence of this enthusiasm is the attendance of 50 that has been the average at these sessions.

Virginia Military Institute

During February the Virginia Military Institute Student Chapter held two regular meetings. On the 19th Worthington Faulkner, personnel officer for the Blueridge Company, of Glasgow, Va., addressed the Chapter on some of the problems confronting a personnel director. The second meeting took place on February 25, and the three speakers on this occasion were Cadets Ellis, Seaton, and Hughes. At both sessions plans were discussed for the annual conference of Student Chapters in the state, which was to be held at Virginia Military Institute on April 9. On February 23 Cadet P.M. Gwaltney, a Student Chapter member, gave a talk on the Sperry Rail Detector Car at the annual meeting of the Virginia Section of the Society.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for June

WITH the current number, CIVIL ENGINEERING has departed from its custom of publishing in a single issue all the papers presented at a quarterly meeting of the Society. Abstracts of four of the Jacksonville papers appear this month; about half the remaining ones will be printed in June, and the other half in July. Interspersed among them will be other papers, from other sections of the country, on phases of civil engineering work not included in the Meeting program.

The Jacksonville papers scheduled for June deal with surveying, hydrologic studies, roads, and river improvements in the Southeast (especially in Florida), and with beach-erosion control in Texas and Massachusetts.

From California, R. B. Ward, Assoc. M. Am. Soc. C.E., contributes an article on construction features of the Cajalco Reservoir, the main storage unit for the distribution system of the Metropolitan Water District's Colorado River project. The methods of placing and compacting the fill and paving the upstream face of the main dam and dike are of especial interest.

COMPACTING THE FILL AT CAJALCO DAM

In the sanitary engineering field, Clarence W. Hubbell, M. Am. Soc. C.E., writes of the background of Detroit's sewage disposal project—the continuous increase in pollution of the Detroit River, the ever-increasing cost of maintaining a safe water supply, and the repeated earlier attempts to provide adequate facilities for treatment of sewage.

It is hoped that a paper by D. B. Steinman, M. Am. Soc. C.E., on the design of the Thousand Islands bridge may also be included.

Bibliography of Suspension Bridges Issued

"A HISTORY of Suspension Bridges in Bibliographical Form" is the title of a 587-page mimeographed book just presented to the Society by its author, A. A. Jakkula, Assoc. M. Am. Soc. C.E. The volume contains a total of 3,950 references to suspension bridges and is thought to be the most comprehensive bibliography ever compiled on the subject. It has been arranged in such form that it is also a history of suspension bridges, for the bridges have been arranged chronologically by date of completion and the references to articles on each bridge are also in chronological order. A complete subject index is provided, with each bridge listed under several headings—such as name, location, and river—so that references can be found even though only partial information about the bridge is at hand.

Professor Jakkula's project has been made possible by help furnished by several agencies, namely the Graduate School, University of Michigan; the Federal Emergency Relief Administration; the National Youth Administration; and the Civil Engineering Department, University of Michigan. The bibliography is now on file in the Engineering Societies Library, 29 West 39th Street, New York, N.Y.

Closing Date for Arc Welding Foundation Contest Papers Only One Month Away

THE $200,000 contest sponsored by the James F. Lincoln Arc Welding Foundation to stimulate intensive study of arc welding is drawing to a close. By June 1, all papers entered for any of the 446 prizes must be on file in duplicate with the secretary of the foundation, A. F. Davis (P.O. Box 5728, Cleveland, Ohio).

Complete details of the contest can still be obtained from Mr. Davis. With the thought that a number of members of the Society may still wish to enter, a part of the announcement appearing in CIVIL ENGINEERING for March 1937 is repeated below:

"The principal prize winner will receive not less than $13,700. Other prizes range from $7,500 to $100, the latter sum to be awarded each of 178 contestants whose papers are adjudged worthy of honorable mention.

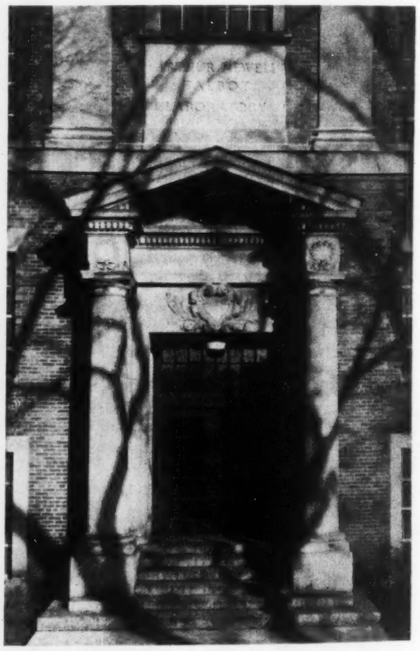
"Of especial interest to civil engineers are the 'structural' and 'containers' divisions. In the former, 24 prizes are offered, with a total value of $14,200. Four subclassifications are established in this division, namely, 'buildings,' 'bridges,' 'houses,' and 'miscellaneous.' In the 'containers' division, there will be 14 prizes with a total value of $10,500. The subclassifications are 'contents stationary' and 'contents moving.'

"Papers must either describe the redesign of an existing machine, structure, building, etc., so that arc welding may be applied to its manufacture; or they must present a design (either in whole or in part) of a machine, structure, building, etc., not previously made—the description to show how a useful result, impractical with other methods of construction, is obtained by arc welding."

The foundation has announced that the full amount set aside for prizes will be distributed in any case. That is, a lack of meritorious papers in any classification will simply increase the cash value of other prizes.

A. N. Talbot Receives New Honor from Alma Mater

THE Materials Testing Laboratory at the University of Illinois was renamed the Arthur Newell Talbot Laboratory at a convocation ceremony on April 21, 1938. Already the recipient of the highest awards conferred by the societies of his professional interests (including the presidency and honorary membership of the American Society of Civil Engineers), Doctor Talbot was thus honored by his alma mater for the brilliantly active years as a teacher and investigator that have contributed so much to the University of Illinois and to the engineering profession.



THE ARTHUR NEWELL TALBOT LABORATORY

Robert Ernest Doherty, Illinois, '09, president of the Carnegie Institute of Technology, Pittsburgh, Pa., gave the principal address at the afternoon ceremony. A banquet and reception in the evening of the same day brought the celebration to a close.

The University of Illinois has published a booklet entitled "A Tribute to Arthur Newell Talbot," commemorating the renaming of the laboratory. It has been sent to a large number of friends of Doctor Talbot and the university, and a limited number of copies are still available upon application to Prof. F. E. Richart, College of Engineering, Urbana, Ill.

Another in the Series of "Art in Engineering"

Pictured on the Page of Special Interest is a triple-arch bridge which spans a concrete dam in Sharon Woods Park, Ohio. Exemplifying beauty, simplicity, and utility in small-bridge construction and blending as it does with its natural setting, it finds a place in the series being featured in Civil Engineering under the title of "Art in Engineering." Reproduction of this photograph in Civil Engineering was made possible through the cooperation of *The Highway Magazine*, published by members of the Armco Culvert Manufacturers Association.

Regional Conference of Surveying Teachers Held at Troy, N.Y.

Under the auspices of the Society for the Promotion of Engineering Education, the first regional Surveying Teachers Conference was held on March 24–26, at Rensselaer Polytechnic Institute, Troy, N.Y. Delegates from ten northeastern states, representing 24 colleges, were in attendance. Subjects of discussion included the importance of accurate maps in planning operations; state plane coordinate systems; teaching and practice of land surveying and photogrammetry; control for aerial surveys; practical applications of aerial surveys; and the use of plotting equipment in photogrammetry.

Unanimous opposition was expressed by the conference to the congressional bill proposing a change in the standard U. S. inch, and a resolution to that effect was forwarded to each member of the Congressional Committee on Coinage, Weights, and Measures of the House of Representatives. While the change in the standard inch would amount to only 1 part in 500,000, it was pointed out that it would make necessary the recomputation of all the work done to date on state plane coordinate systems. The conference recommended that the bill be not passed without careful consideration by committees of the American Society of Civil Engineers, American Geophysical Union, and the Federal Board of Surveys and Maps.

Society Members Honored by A.R.E.A.

Several members of the Society were among those honored at the thirty-ninth annual meeting of the American Railway Engineering Association, which was held in Chicago March 15–18, 1938. Four former presidents of that organization—William B. Storey, Charles A. Morse, J. G. Sullivan, and J. L. Campbell, all Members of the Society—were elected to honorary membership in the association.

The election of new officers resulted in the selection of F. E. Morrow, M. Am. Soc. C.E., chief engineer of the Chicago and Western Indiana Railroad, as president. E. M. Hastings, M. Am. Soc. C.E., automatically became first vice-president, and W. S. Lacher, Assoc. M. Am. Soc. C.E., assumed his duties as secretary. George S. Fanning, chief engineer of the Erie Railroad, is second vice-president.

International Problems Topic of Social Science Academy Annual Meeting

Present international tensions were the general topic of the forty-second annual meeting of the American Academy of Political and Social Science, held at Philadelphia on April 1 and 2. The Society's representative at the meeting, B. F. Hastings, has supplied some interesting comments on the discussions.

"The speakers in the session on the doctrine of self-sufficiency," he writes, "made the following claims: (1) National policies of self-sufficiency pave the way for war; (2) if countries do not have access to resources through a system of international exchange, there is only one way to obtain them—that is, military and political occupation of other territories; (3) the cost of self-sufficiency among the majority of the nationalistic nations is apparently greater than the cost of cooperation; (4) national planning seems to be leading the world into another World War.

"Free traders had a field day at the session on trade barriers. The speakers apparently tried to establish the point that the present condition of the world was due to tariff activities in general, and American tariff activities in particular.

"The third session—'Some Aspects of the Tension'—posed the problem of why some countries with limited resources should be considered as 'have-not' nations, while others are not considered so. It was contended that the 'have-not' phrase is actually one of the basic lines of propaganda of the aggressor nations."

Traffic Planning Helps Cities Win Safety Council Awards

Safe traffic planning and construction was an important factor in determining the winning cities and states in the National Safety Council's sixth annual traffic safety contest, results of which were announced last month. The grand prize was awarded to Memphis, Tenn., and first-place prizes for cities in other population groups went to Milwaukee, Wis.; Hartford, Conn.; Beaumont, Tex.; and Sacramento, Calif.; Everett, Wash.; and Des Plaines, Ill. In the contest between states, Massachusetts was the national winner, with Oklahoma, North

The Southeast Wing of This New Men's Residence Hall at the University of Colorado Has Been Named Ketchum Hall in Honor of the Late Milo S. Ketchum, Hon. M. Am. Soc. C.E., Former Dean of the University's College of Engineering

Building Consists of Two Connected U-Shaped Units and Accommodates 450 Students. The Four Wings Have Been Named for Men Now Deceased Who Were Instrumental in Establishing Early Fundamental Educational Policies at the University

ANNUAL CONVENTION of the Society, Salt Lake City, Utah, July 20–22, 1938

Dakota, and Nevada ranking first in their respective sections.

During 1937 Memphis did away with four grade crossings, conducted 100 surveys to determine view obstruction at danger points, installed 36 miles of new paving (including a long by-pass route along the Mississippi), and marked 40 miles of pavement to direct vehicles into proper lanes. Other engineering activities in winning cities included traffic counts, speed checks, construction of safety islands, installation of stop lights, cutting back curbs at intersections, and standardization of traffic signs and signals.

The grading system adopted for the contest allowed 50 points for low death rate and reduction of death rate from traffic accidents; and divided the remaining 50 points among traffic planning and construction, traffic law enforcement, safety education programs, and completeness in accident reporting.

Brief Notes from Here and There

PROBLEMS facing the construction industry in its efforts to bring about a restoration of building enterprise will be prominently before the twenty-sixth annual meeting of the Chamber of Commerce of the United States, to be held in Washington, D.C., May 2 to 5. A special group session on May 4 will emphasize the responsibility of localities for improving housing conditions and will discuss the programs of the building industries for promoting small-house building. Among the leaders of discussion will be Don A. Campbell, of Lebanon, Ky., president of the National Retail Lumber Dealers Association, and Ernest T. Trigg, of Washington, D.C., president of the National Paint, Varnish and Lacquer Association. A. P. Greensfelder, M. Am. Soc. C.E., of St. Louis, will preside.

* * * *

USE of the spectroscope may some day largely replace the time-consuming chemical methods of determining the composition of metals and their alloys. It is only recently that the spectroscope has been applied to quantitative analyses, but a number of large industrial concerns are already using it for that purpose. The Navy, also, is finding it of value; it is not only rapid but accurate, and it provides a permanent photographic record of each test. Navy research on the subject is described in the Journal of the American Society of Naval Engineers for February 1938.

* * * *

THE Massachusetts Institute of Technology has announced that a special summer program and conferences on strength of materials will be held at the Institute, Cambridge, Mass., from June 13 to July 8, 1938. Many persons unable to attend the entire series will wish to make special note of the conferences on concrete and timber scheduled for July 7 and 8. A detailed program can be secured from Prof. J. M. Lessells, of the Department of Mechanical Engineering of the Institute.

* * * *

THE engineering profession may well be proud of its part in the development of the Rio Grande Compact, which was signed by the commissioners of the states of Colorado, New Mexico, and Texas on March 18, and which when ratified will put an end to forty years of controversy between the states as to their rights to the waters of the Rio Grande. The document was largely drawn by a committee of engineers, one from each state and one representing the United States, and it is reported to be the opinion of the commissioners that the compact could not have been consummated without the efforts of the engineering advisers.

* * * *

STEVENS Institute of Technology announces its eighth annual economics conference, to be held at Johnsonburg, N.J., June 24 to July 2. This year the Society for the Advancement of Management will be a joint sponsor. Four sessions daily throughout the week are scheduled on motion and time study, human relations, marketing, industrial management, and management problems. As usual, a number of prominent industrialists, economists, and professors have been selected to address the evening meetings.

* * * *

THE need for a topographic mapping program in the United States, as proposed in the Hayden-Ickes bill, was stressed in a recent broadcast sponsored by Armour Institute of Technology over WCFL. J. C. Penn, M. Am. Soc. C.E., professor of civil engineering at the Institute, was the speaker.

* * * *

AFTER six semi-annual meetings, the "New England Photoelasticity Conference" becomes the "Eastern Photoelasticity Conference." It will convene at Harvard University on May 14 for a one-day session. Membership is entirely informal, and those interested are invited to communicate with the chairman, R. W. Vose, Jun. Am. Soc. C.E.

* * * *

ENGINEERS and traffic administrators from 65 countries will meet at The Hague, Holland, on June 20, the opening date of the Eighth International Road Congress. Recent progress in road construction and traffic engineering, and the interrelationship of these subjects, are topics listed for discussion. The American Organizing Committee for the Congress, under Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, is handling arrangements for United States delegates.

* * * *

"A Technical Review of the Norris Project" has been published by the Tennessee Valley Authority to answer the many requests for information on that development. The book includes a narrative description and statistical summary, photographs of construction and completed structures, and 34 drawings showing the principal plans, sections, and details of the dam, as well as the construction plant, typical concrete mixes, construction schedules, and so forth. Copies, at $1 each, can be secured from the Information Office of the TVA, Knoxville, Tenn.

* * * *

ROADSIDE development sessions held at the annual meeting of the Highway Research Board, National Research Council, are summarized in a 52-page report recently issued by the board. Advances in the technique and scope of highway landscape activities during 1937 are outlined, and the accomplishments of six subcommittees are listed in abstract form. The latter include Erosion, Education and Public Relations, Zoning, Highway Types and Roadside Areas, Plant Materials, and Roadside Development Cost Records. The report can be obtained from the Highway Research Board, 2101 Constitution Avenue, Washington, D.C., at 25 cents a copy.

* * * *

THE Board of Engineers for Rivers and Harbors of the U. S. War Department has just issued a revision of the report on Transportation on the Great Lakes, which was last published in 1930. The report is No. 1 of the "Transportation Series," dealing with transportation problems directly related to the functions of the War Department. It contains a general description of the Great Lakes and their connecting channels and harbors, information relative to laws, treaties, and regulations concerning navigation and traffic, and an extensive study of the movements of the important bulk commodities. Copies can be obtained from the Superintendent of Documents, Washington, D.C., at $1.75 each.

NEWS OF ENGINEERS

Personal Items About Society Members

FREDERICK N. CRONHOLM announces the opening of a consulting hydraulic engineering office at Redlands, Calif., where he will specialize in work simplification.

L. D. GRAHAM, lieutenant-commander in the U. S. Coast and Geodetic Survey, has been made inspector of the New Orleans field office of the Survey.

E. T. JENSEN is now civil engineer for the Western Contracting Corporation (formerly the Western Asphalt and Paving Company), with headquarters in Sioux City, Iowa. His work will consist of developing and building up a job layout department.

MURRAY BLANCHARD has closed his consulting office in Chicago to accept a position with the Corps of Engineers, U. S. Army, in charge of the suboffice of the Cincinnati District at Columbus, Ohio. This office was recently established for the purpose of making flood-control investigations and studies.

John V. Zahlén, who since 1932 has been studying geology, physics, geography, and economics at the University of Basle in Switzerland, was recently awarded the degrees of doctor of philosophy and master of liberal arts. Mr. Zahlen is now returning to the United States.

John S. Wiley has resigned as assistant sanitary engineer with the South Dakota State Board of Health to accept the position of assistant engineer in the Bureau of Industrial Hygiene of the Indiana State Board of Health. His headquarters are in Indianapolis, Ind.

James B. Hommon, formerly transitman for the U. S. Bureau of Reclamation on the construction of Bartlett Dam, is now junior engineering aide in the California Department of Public Works, Division of Highways. He is located at Stockton, Calif.

Karl R. Kennison, assistant chief engineer of the Metropolitan District Water Supply Commission, was elected president of the Boston Society of Civil Engineers at the annual meeting of the Society held in Boston on March 16.

John M. Page, senior highway engineer for the U. S. Bureau of Public Roads, has been elected president of the Arkansas Society of Engineers.

Marion L. Crist is now engineer for the Little Rock Municipal Water Works, Little Rock, Ark. He was previously associate engineer for the Burns and McDonnell Engineering Company of the same city.

James J. Zerbe, until recently in the structural department of Smith, Hinchman and Grylls, Inc., of Detroit, Mich., has accepted a position as senior inspector in the Detroit Department of Public Works.

C. V. Youngquist has been promoted from the position of associate hydraulic engineer for the U. S. Geological Survey, Water Resources Branch, to that of district engineer of the same division, with headquarters in Columbus, Ohio.

Leonor F. Loree recently resigned as president and director of the Delaware and Hudson Railroad because of failing health. Mr. Loree was with this organization for many years and had served as president and director since 1907.

I. N. Carter, associate professor of civil engineering at the University of Idaho, has been appointed acting head of the department of civil engineering.

Donald D. Price has accepted the position of technical engineer with the Ash Grove Lime and Portland Cement Company, of Omaha, Nebr. He was formerly chief engineer and general manager of the Platte Valley Public Power and Irrigation District at North Platte, Nebr.

LaMotte Grover, previously in the bridge department of the Missouri Pacific Railroad, has been made instructor in applied mechanics at the Kansas State College of Agriculture and Applied Science.

Arthur R. Hahn, until recently with the Portland Cement Association, has become connected with the Hanley Company, of New York City, in the capacity of sales engineer of face brick and ceramic products in northern New Jersey.

Malcolm Elliott, lieutenant-colonel, Corps of Engineers, U. S. Army, has assumed the duties of division engineer for the Upper Mississippi Valley Division, with headquarters at St. Louis, Mo. He was previously assistant to the division engineer.

Carl A. Anderson is now chief engineer for the San Carlos Irrigation and Drainage District at Florence, Ariz. Mr. Anderson was formerly in charge of the Willacy County Water Control and Irrigation District.

Frank W. Chappell announces the reopening of offices for the practice of structural and industrial engineering in the Burt Building, Dallas, Tex. Until recently Mr. Chappell was engineer examiner for the PWA at Dallas.

Lynn O. Knowlton is now a partner in the firm of Graham and Knowlton, architects and engineers, with headquarters in the Security Trust Building, Indianapolis, Ind.

Louis R. Howson, consulting engineer of Chicago, Ill., has been appointed a member of the department of registration and education of the Illinois Board of Natural Resources and Conservation.

Harold M. Lewis is now chief engineer and secretary of the Regional Plan Association, Inc., in general charge of the staff of the Association. He was previously engineer and planning consultant of the organization.

F. S. Borden has been given command of the U. S. Coast and Geodetic Survey ship, *Oceanographer*. He was formerly in command of the Survey ship, *Hydrographer*, which will now be commanded by George C. Mattison, who leaves the post of inspector of the New Orleans field office of the Survey to assume this command.

Walter H. Starkweather, formerly technical assistant engineer to the chief civil engineer, U. S. Coast Guard, Washington, D.C., has been made division civil engineer for the Seattle Division of the Coast Guard, with headquarters in the National Building, Seattle. The territory in this Division includes Oregon, Washington, and Alaska.

John H. Gaynor has opened an office at 233 Broadway, New York City, for the general practice of law in conjunction with his engineering work. He will continue to follow his present activities in advice and selection of engineering personnel.

Charles S. Boardman has been appointed consulting engineer in the specialty sales division of the Carnegie-Illinois Steel Corporation, with headquarters in Pittsburgh, Pa. Until recently Mr. Boardman was with the Jones and Laughlin Steel Corporation.

Joseph F. Kunesh, previously assistant chief engineer for the Board of Water Supply, City of Honolulu, is now director of the Territorial Planning Board, with headquarters in Honolulu.

DECEASED

Armando Manuel Alvarez y de Urrutia (M. '32) manager and chief engineer of the Lima (Peru) office of the Frederick Snare Corporation, died on July 28, 1937, at the age of 40. A native of Cuba, Mr. Alvarez was educated there and in the United States. Returning to Cuba in 1918, he joined the staff of the Frederick Snare Corporation as an assistant engineer on field studies and reports. He went to Peru in 1928 after the Frederick Snare Corporation was awarded the contract for the Callao port works.

Forrest McKendree Casey (Assoc. M. '31) assistant engineer, Bureau of Engineering, City of Los Angeles, died on March 19, 1938, at the age of 54. Mr. Casey's early engineering experience was with the Los Angeles engineering department. In 1923, after several years with the General Petroleum Corporation of Los Angeles and the Southern California Edison Corporation, he again became connected with the Los Angeles engineering department. He was responsible for the design of storm-drain systems for a large section of the city.

Clarence Derrick (Assoc. M. '10) died in Wallingford, Conn., on March 20, 1938, at the age of 58. In 1911, after several years in bridge engineering work, he became connected with the Berlin Consulting Company at Berlin, Conn. He remained there in the capacity of designing engineer and estimator until 1936, when illness forced him to resign.

Samuel Alexander Hart (Assoc. M. '16) senior engineer in the California State Department of Public Works, died in Sacramento, Calif., on March 20, 1938, at the age of 52. Mr. Hart was in the service of the City of Sacramento from 1922 until 1928—as second assistant engineer, assistant city engineer, and city engineer, successively. After two years as sanitary engineer for the City of Berkeley (Calif.), he became senior engineer for the California State Department of Public Works. During the war Mr. Hart served as first lieutenant with the A.E.F.

VICTOR KING HENDRICKS (M. '11) died at his home in Oak Park, Ill., on March 19, 1938, at the age of 68. From 1907 to 1920 Mr. Hendricks was with the St. Louis and San Francisco Railroad—as assistant engineer, assistant chief engineer, and chief engineer, successively. In 1920 and 1921 he was regional engineer for the Southwestern Region of the U. S. Railroad Administration. Later he engaged in miscellaneous railroad engineering work.

TILLINGHAST L'HOMMEDIEU HUSTON (Assoc. M. '00) of Brunswick, Ga., died suddenly on March 29, 1938, at the age of 71. Colonel Huston helped organize the 2d Volunteer Engineers regiment at the outbreak of the Spanish-American War and served in Cuba. After the war he remained in Havana for a number of years and engaged in harbor and river improvement, and sanitary engineering work. Later he became half-owner of the New York Yankees, when it was developing into a championship baseball team. During the World War Colonel Huston served with the 16th Engineers in France.

CHARLES HERBERT JOHNSON (M. '32) assistant chief engineer of the Nashville Chattanooga, and St. Louis Railway, Nashville, Tenn., died on March 9, 1938, at the age of 60. Except for a brief period with the Gould Contracting Company, Mr. Johnson was in the employ of the Nashville, Chattanooga and St. Louis Railway from 1900 until his death. In 1931 he became assistant chief engineer.

EDWARD PERCY LANE (Assoc. M. '09) retired civil engineer, died in Brattleboro, Vt., on March 19, 1938, at the age of 60. For a number of years Mr. Lane was in the employ of the New York Central Railroad. Later he was associated with the Elmira Bridge Company, the Boston and Main Railroad, and the Stone and Webster Engineering Corporation. He retired in 1924.

THOMAS FRANCIS MCQUADE (M. '26) assistant engineer for the New York City Board of Transportation, died in that city on April 5, 1938, at the age of 60. In 1912, after numerous engineering activities, he was appointed to the Bureau of Design, Borough of Bronx. From 1918 to 1922 he was assistant engineer for the Borough of Richmond, and from 1922 to 1926 section engineer for the New York City Board of Water Supply. In the latter year he became assistant engineer for the Board of Transportation.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

FREDERIC ALBERT MOLITOR (M. '96) retired consulting engineer, died in Stamford, Conn., on March 12, 1938, at the age of 69. Colonel Molitor, who commanded the 22d Regiment in France during the war, was a railroad engineer for twenty-two years before he entered private practice in New York in 1908. His subsequent work as a consultant took him to South America, Mexico, and Europe as well as to all parts of the United States. From 1906 to 1908 he made a survey of the railroad situation in the Philippines for President Theodore Roosevelt.

CHARLES REAL OLBERG (M. '22) hydraulic engineer for the Resettlement Administration, Washington, D.C., died in that city on April 4, 1938, at the age of 60. Major Olberg was supervising engineer with the U. S. Indian Service from 1907 to 1917, and assistant chief engineer from 1919 to 1929. He designed the Roosevelt and Coolidge dams, and for four years was engaged in reclamation enterprises for the Soviet Union. Upon his return from Russia, he was called to pass upon many government reclamation projects. During the war Major Olberg served with the A.E.F. in France.

CHARLES EDWARDS PERRY (M. '16) district engineer for the U. S. Engineer Office at Nashville, Tenn., since 1934, was drowned in the Tennessee River on March 14, 1938, while making an inspection of Wheeler Dam. He was 59. Colonel Perry had been with the U. S. Corps of Engineers for over twenty years and had been stationed in Manila, New York City, Washington, Fort Logan, Colo., and other posts. Prior to his connection with the Corps of Engineers, Colonel Perry maintained an engineering practice in Gloversville and Canajoharie, N.Y., and, later, in Albany.

CHARLES STOCKTON POPE (M. '13) construction engineer for the California Division of Highways, died at Riverside, Calif., on March 16, 1938, at the age of 63. Mr. Pope was in the employ of the City of Los Angeles from 1907 to 1915—finally as supervising engineer of street construction. He was then connected with several private engineering enterprises, and in 1925 he became construction engineer for the California Division of Highways.

WILLIAM KERPER RUNYON (M. '22) for the past sixteen years on the staff of the Los Angeles County Surveyor, died in San Marino, Calif., on February 28, 1938, at the age of 61. Mr. Runyon spent many years as resident engineer on railroad construction in Cuba, China, and South America, and during the war he served as office engineer for the U. S. War Department in Washington. In 1922 he entered the Los Angeles County Surveyor's office.

WILLIAM ROBERT SCANLIN (M. '30) chief engineer for the Philadelphia Rapid Transit Company, Philadelphia, Pa., died on March 30, 1938, at the age of 52. Most of Mr. Scanlin's engineering career was spent in the service of the Philadelphia Rapid Transit Company, where he started as a draftsman in 1903. Later he was assistant engineer, structural engineer, assistant to the vice-president, and (since 1927) chief engineer.

ALBERT SMITH (Assoc. M. '92) died at his home in Saltsburg, Pa., on August 20, 1936, at the age of 73. For a number of years he was a member of the firm of Wilson and Smith, specializing in coal surveys and municipal work. From 1903 to 1907 he was borough engineer of Blairsville, Pa. Mr. Smith then became mining engineer for the Graff Coal Company, of Blairsville, where he remained until his retirement five years before his death.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From March 10 to April 9, 1938, Inclusive

ADDITIONS TO MEMBERSHIP

ADAMS, MILTON PRAY (M. '38), Executive Secy. and Engr., Michigan Stream Control Comm., Lansing (Res., 538 Park Lane, East Lansing), Mich.

AIKIN, HENRY BOBBITT (Assoc. M. '38), Asst. Prof., Civ. Eng., Univ. of Tennessee (Res., 2231 Laurel Ave.), Knoxville, Tenn.

ALBERT, JOSEPH LOGSDON (Jun. '38), Asst. Engr., North Platte Defense, State of Wyoming, Box 443, Cheyenne, Wyo.

ALLISON, FRED GRAY (Affiliate, '38), Research Engr., Div. of Tests and Investigations, State Highway Board of Georgia, Box 1303, Atlanta, Ga.

ANDERSON, RANDOLPH ERLAND (Jun. '38), 97 Eltingville Boulevard, Eltingville, N.Y.

ARNING, LOUIS HENRY (Jun. '38), Junior Engr., Hydr. Section, U. S. Engr. Office, Rock Island, Ill.

ATESHOGLOU, ANASTASIS DEMETRE (Jun. '37), General Delivery, Blackshear, Ga.

BAILEY, EARNEST ALBERT (Assoc. M. '38), Care, TVA, 501 Union Bldg., Knoxville, Tenn.

BARNETT, THOMAS EDWARD (Jun. '37), With Transit Equipment Co., 501 Fifth Ave., New York (Res., 951 St. Johns Pl., Brooklyn), N.Y.

BEALL, WILLIAM STANLEY (Jun. '37), 710 Maple St., Bethlehem, Pa.

Bowron, Charles Edward (M. '38), Chf. Engr., Gulf States Steel Co. (Res., 2175 Eleventh Court, South), Birmingham, Ala.

Bull, Thomas Emery (Jun. '37), 304 North 4th St., Oregon, Ill.

Buxton, Alfred Culver (Jun. '38), Structural Draftsman, W. P. Neil Co., Ltd., Los Angeles (Res., 507 Tenth St., Santa Monica), Calif.

Callahan, Joseph Cal (Jun. '38), 2327 Symmes St., Cincinnati, Ohio.

Carlson, Leonard Arthur (Jun. '38), Asst. Engr., Corps of Engrs., U.S.A., Rock Island (Res., 1439 Thirteenth St., Moline), Ill.

Christofferson, Le Grand (Jun. '37), Field Engr. and Elec. Welding Insp., Chicago Bridge & Iron Co., 1305 West 105th St., Chicago, Ill.

Closson, Edgar George (Jun. '37), 815 Erie Ave., Logansport, Ind.

Crabtree, Frederick Howard (Assoc. M. '38), Asst. Dean, Eng. School, Tufts Coll., Medford, Mass.

Curtin, John Francis (Jun. '38), 3 Sacramento St., Cambridge, Mass.

Dekema, Jacob (Jun. '37), 2306 Buckingham Rd., Los Angeles, Calif.

Deveney, James Campbell (Jun. '38), Job Supt., C. H. Cunningham & Co., Inc., 31 Exchange St., Lynn (Res., 26 Sunset Rd., Nahant), Mass.

Donovan, John Padraic (Assoc. M. '38), 770 South Schuylkill Ave., Philadelphia, Pa.

duRell, Charles Terry (M. '38), 601 Hermosa Ave., Redondo Beach, Calif.

Elden, William Robert, Jr. (Jun. '37), Asst. to County Commr. of Highways, Piatt County, Court House, Monticello (Res., 1010 North Church St., Decatur), Ill.

Eustis, Ernest Lewis, Jr. (Jun. '38), Surv., Caribbean Petroleum Co., Maracaibo, Venezuela.

Everham, Arthur Thompson (Jun. '38), Engr., Raymond Concrete Pile Co., 311 South Spring St., Los Angeles, Calif.

Ewoldt, Charles Parker (Jun. '37), 257 Sandusky St., Conneaut, Ohio.

Eyster, Lamar Daugherty (Assoc. M. '38), Res. Engr. on Constr., State Highway Dept., Scottsboro, Ala.

Foster, Edward Terence (Assoc. M. '38), Supt. of Constr., Omaha Steel Works (Res., 4914 Capitol Ave.), Omaha, Nebr.

Goldberg, Joseph Joshua (Jun. '37), 1641 Overing St., New York, N.Y.

Groves, Henry George (Assoc. M. '38), 2705 Eleventh Ave., North, Billings, Mont.

Harding, Louis Allen (M. '38), Pres., Harding-Carlton Corporation; Commr., Dept. of Public Works, City of Buffalo (Res., 85 Cleveland Ave.), Buffalo, N.Y.

Hechmer, Carl Adam (M. '38), Dept. Engr., Washington Suburban San. Dist., Hyattsville, Md.

Hewitt, Charles George (Jun. '38), R.D. 1, Salem, N.J.

Hoffmann, Lewis Edward (Jun. '37), Guntersville Dam, Ala.

Jordan, Lawrence Wiley (Assoc. M. '38), Hydrographer, Grade V, Los Angeles County Flood Control Dist., Route 1, Box 1217, Downey, Calif.

Kaiser, Harry Andrew (Jun. '38), With New York Telephone Co., Eng. Dept., 136 Cooper St., Brooklyn, N.Y.

Kastner, Alfred (Assoc. M. '37), Archt. (Kastner & Berla), 2 Dupont Circle, Washington, D.C.

Koogler, Jack Graham (Jun. '37), Dulce, N. Mex.

Leggett, James Llewellyn, Jr. (Jun. '37), 243 Castlewood Drive, Lexington, Ky.

Link, Howard Charles (Jun. '38) , Highwood, Southington, Conn.

Looney, Charles Thomas George (Assoc. M. '38), Asst. Prof., Civ. Eng., State Univ. of Iowa (Res., 21 Woolf Ave.), Iowa City, Iowa.

Maierhofer, Charles Richard (Jun. '38), Care, U. S. Bureau of Reclamation, Govt. Camp, Marshall Ford Dam, Tex.

Maines, Thomas Richard (Assoc. M. '37), Sales Engr., Wilson-Weesner-Wilkinson Co., Box 1226, Knoxville, Tenn.

Mann, John Herbert Claiborne (Assoc. M. '38), Asst. Prof., Civ. Eng., Virginia Military Inst., Lock Box 755, Lexington, Va.

Marum, Edmond Francis (Jun. '37), Care, U. S. Bureau of Reclamation, Cavecreek, Ariz.

Mittet, Holger Peter (Jun. '37), Graduate House, Mass. Inst. Tech., Cambridge, Mass.

Moore, Bernard Caldwell (Jun. '38), 622 Augusta St., San Antonio, Tex.

Moore, William Irvine (Jun. '38), 605 South 5th St., Douglas, Wyo.

Murray, Allen Brainerd (Jun. '38), Richland, Wash.

Nahmias, Harold Albert (Jun. '37), 969 Faile St., New York, N.Y.

O'Connor, Gerald Alexander (Assoc. M. '38), Constr. Engr., Raymond Concrete Pile Co., Apartado 1846, Caracas, Venezuela.

O'Donnell, Herbert Preston (Jun. '38), Junior Highway Engr., State Div. of Highways, Bishop, Calif.

Oleson, Calvin Carl (Assoc. M. '37), Asst. Prof., Civ. Eng., South Dakota State Coll., Brookings, S.Dak.

Patterson, Albert Earl (Assoc. M. '38), Constr. Engr., Procurement Div., Public Buildings Branch, U. S. Treasury Dept., New Post Office Bldg., Lakeview, Ore.

Planas y Valdés, Juan Ignacio (Jun. '37), Steinhart y Robau, Marianao, Havana, Cuba.

Poole, Blucher Adams (Assoc. M. '38), Chf. Engr., Bureau of San. Eng., State Board of Health (Res., 6421 Broadway), Indianapolis, Ind.

Porter, Alan Anderson (Assoc. M. '38), Asst. Engr., Am. Bridge Co., Western Div., Erecting Dept. (Res., 6200 Kenmore Ave.), Chicago, Ill.

Poston, Richard Francis (Assoc. M. '37), Care, State Board of Health, Pierre, S.Dak.

Pou, James Francis (Jun. '38), Asst. Engr. Aide, TVA (Res., 509 Walnut St.), Chattanooga, Tenn.

Prichard, George William (Assoc. M. '38), Francis Scott Key Hotel, Frederick, Md.

Quinn, John Dewey (Assoc. M. '38), State Engr. (Res., 117 East 4th Ave.), Cheyenne, Wyo.

Reed, Paul William (Jun. '38), 724 Walnut St., Fort Wayne, Ind.

Richardson, Louis Alexander (Assoc. M. '38), Asst. Prof., Architectural Eng., Pennsylvania State Coll. (Res., 215 East Irvin Ave.), State College, Pa.

Rowland, William Joseph (Assoc. M. '38), Technical Asst. to Chf. of Soils Section, U. S. Waterways Experiment Station, Box 184, Vicksburg, Miss.

Sachs, Alexander Frederic (Assoc. M. '38), Highway Engr. and Surv., Jackson County, Court House, Kansas City, Mo.

Sanders, Azel Labon Ralph (Assoc. M. '38), Res. Engr., Lafayette Ave. Bridge, Bay City, Mich.

Schulhauser, Edward Victor (Assoc. M. '38), Associate Engr., FSA, U. S. Dept. of Agriculture, 461 Peninsula Ave., San Francisco, Calif.

Shahan, Everett Terry (Jun. '37), Rotary Helper, Humble Oil & Refining Co., Box 1600, Midland, Tex.

Sherick, Ralph Marshall (Assoc. M. '38), Res. Engr., State of California, 453 Twenty-sixth St., Merced, Calif.

TOTAL MEMBERSHIP AS OF APRIL 9, 1938

Members	5,647
Associate Members	6,196
Corporate Members	11,843
Honorary Members	24
Juniors	3,690
Affiliates	79
Fellows	1
Total	15,637

Smith, James Robert (Jun. '37), Conchas Dam, N.Mex.

Smith, Roger Adams (Assoc. M. '37), Care, U. S. Engr. Office, 751 South Figueroa St., Los Angeles, Calif.

Sparks, Robert Earl (Jun. '38), Engr., Sinclair Refining Co., Box 748, Troup, Tex.

Sutherland, Reginald Joseph (Jun. '38), Technical Asst., Bell Telephone Laboratories, 463 West St. (Res., 661 West 180th St.), New York, N.Y.

Tippy, Kenneth Clem (Assoc. M. '38), Field Engr., Portland Cement Assoc., 33 West Grand Ave., Chicago, Ill.

Treece, Clyde Charles (Jun. '38), Engr., Phoenix Eng. Corporation, Box 549, New Orleans, La.

van de Erve, Jerome (Jun. '38), Asst. to Supervisor of Hydrologic Work, U. S. Weather Bureau, Weather Bureau Office, Davenport, Iowa.

Vesco, Arthur (Jun. '37), 326 Summer Ave., Newark, N.J.

Walseth, Erling Sanborn (Jun. '37), 1409 Magnolia Ave., Apartment E, Long Beach, Calif.

Webster, Howard Elwyn (Jun. '38), Lieut., Corps of Engrs., U. S. A., 374 Charles River Rd., Watertown, Mass.

Weyant, Halstead William (Jun. '38), Asst. Dispatcher, Lee & Simmons, Inc. (Res., 325 East 80th St.), New York, N.Y.

Wheeldon, Roscoe Gaffer (Jun. '37), Field Engr., Frank Messer & Sons, Inc., Cincinnati, Ohio (Res., Waynesburg, Ky.)

Wright, Clement Wayne (Assoc. M. '38), Asst. to Dist. Mgr., Rio Grande Dist., SCS, Navajo Service, Window Rock, Ariz.

Membership Transfers

Bangert, Nelson Richard (Jun. '29; Assoc. M. '38), Asst. Maintenance Engr., State Div. of Highways, Public Works Bldg. (Res., 1343 Vallejo Way), Sacramento, Calif.

Bullock, Virgil William (Jun. '25; Assoc. M. '27; M. '38), Structural Engr., Los Angeles County Mech. Dept., Hall of Records, Los Angeles (Res., 251 Covina Ave., Long Beach), Calif.

Burland, Carlyle Gray (Jun. '34; Assoc. M. '38), Res. Engr., Junior Civ. Eng., Dept. of Public Works, Div. of Highways, Commonwealth of Massachusetts, 100 Nashua St., Boston (Res., 18 Cottage Pl., Leominster), Mass.

Disario, Gabriel Michael Anthony (Jun. '28; Assoc. M. '38), Chf., San. Div., Ministry of Public Works (Res., 34 Ave. Los Jabillos, La Florida), Caracas, Venezuela.

Eriksen, Edward Leerdrup (Assoc. M. '23; M. '37), Prof. and Head of Dept. of Eng. Mechanics, Univ. of Michigan, Ann Arbor, Mich.

Flagg, Herbert Judson (Jun. '11; Assoc. M. '20; M. '38), Chf. Engr., Board of Public Utility Commrs. of New Jersey, 1060 Broad St., Newark (Res., 146 Melrose Pl., Ridgewood), N.J.

Gelabert D'Elias, Ramón (Jun. '34; Assoc. M. '38), Vice-Pres. and Gen. Mgr., Soller Sugar Co., Inc., Arecibo, Puerto Rico.

Ghiglione, Angelo Francesco (Jun. '31; Assoc. M. '38), Asst. Supt., Alaska Road Comm., McKinley Park, Alaska.

Hansman, Arthur Francis (Jun. '32; Assoc. M. '38), Mgr. and Engr., Capitol Steel & Iron Co., 203 South Lansing St., Tulsa, Okla.

Hough, Benjamin Kent, Jr. (Jun. '28; Assoc. M. '38), Engr., U. S. Engr. Dept., U. S. Engr. Office, Ithaca, N.Y.

Hunter, Archibald Daniel (Jun. '31; Assoc. M. '38), Lieut., C.E.C., U. S. N., Asst. Civ. Engr., Public Works Div., U. S. Navy Yard, Pearl Harbor, Hawaii.

McLean, Cecil John (Assoc. M. '25; M. '38), Hydr. Engr., Illinois Northern Utilities Co., 421 West 1st St., Dixon, Ill.

McNeil, Donald Miller (Jun. '27; Assoc. M. '38), Traffic Engr., City of Pittsburgh, 908 City-County Bldg. (Res., 3340 McNeil Pl.), Pittsburgh, Pa.

Merritt, Will Dockery (Jun. '28; Assoc. M. '38), City Engr., Box 373, Mount Airy, N.C.

Morris, Robert Beverly (Jun. '36; Assoc. M.

'38), Asst. Engr., PWA (Res., 318 Delafield Pl., N.W.), Washington, D.C.

Niederhoff, August Evan (Jun. '30; Assoc. M. '38), Head of Structural Design Section on Dams, U. S. Engr. Office, 751 South Figueroa St., Los Angeles, Calif.

Peterson, Frederick Gust (Jun. '29; Assoc. M. '38), Supt., Winston Bros. Co. (Res., Gunderson Apartments, Kenwood), Helena, Mont.

Ranlett, Charles Augustus, Jr. (Jun. '32; Assoc. M. '38), Headquarters, 3d CCC Dist., Fort Devens (Res., Billerica), Mass.

Reed, Garner Wade (Jun. '33; Assoc. M. '37), Asst. Engr., Port of New York Authority, 111 Eighth Ave., New York (Res., 75 Beechwood Ave., Port Washington), N.Y.

Schnackenberg, Ellis Carl (Jun. '33; Assoc. M. '37), Asst. Engr., Public Works Dept. (Res., Onehunga), Auckland, New Zealand.

Stickney, Edward Elias (Assoc. M. '28; M. '38), Associate Engr., Bridges, Div. of Highways, State Dept. of Public Works, Binghamton, N.Y.

Truss, Felix Warner (Assoc. M. '28; M. '38), Civ. Eng. TVA, Commercial Bank and Trust Co. Bldg., Paris, Tenn.

Van Houten, Robert Wallace (Jun. '31; Assoc. M. '38), Asst. Prof., Civ. Eng., Newark Coll. of Eng., 367 High St., Newark (Res., 20 Norwood Terrace, Maplewood), N.J.

Watson, John Dargan (Jun. '28; Assoc. M. '38), Asst. in Civ. Eng., Graduate School of Eng., Harvard Univ., 8 Pierce Hall, Harvard Univ., Cambridge, Mass.

Wells, Joseph Van Brunt (Jun. '30; Assoc. M. '38), Asst. Engr., U. S. Geological Survey, Box 130, Harrisburg, Pa.

Reinstatements

Eccles, Alfred Harvey, Assoc. M., reinstated Mar. 17, 1938.

Powell, Willis Maynor, Assoc. M., reinstated Mar. 14, 1938.

Resignations

Cawood, Keith Crews, Jun., resigned Mar. 31, 1938.

Chapin, Richard Norman, Assoc. M., resigned Mar. 23, 1938.

Cronyn, Theodore, Assoc. M., resigned Apr. 7, 1938.

Demarest, Richard Terhune, Jun., resigned Apr. 5, 1938.

de Westfelt, Gerard Philip, Assoc. M., resigned Mar. 15, 1938.

Rubins, Ralph Edward, Assoc. M., resigned Mar. 22, 1938.

Sandifer, Douglas Albert Neville, Assoc. M., resigned Mar. 8, 1938.

Thompson, Milton Theodore, M., resigned Mar. 21, 1938.

Thum, Charles Theodore, Jun., resigned Mar. 31, 1938.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

May 1, 1938 NUMBER 5

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

Andersen, Morris Lloyd, Lincoln, Nebr. (Age 23.) Refers to H. J. Kesner, C. E. Mickey.

Bartz, Richard Herman, Jr., Chicago, Ill. (Age 24.) Draftsman, Frank F. Fowle & Co., Cons. Engrs. Refers to J. G. Bennett, D. C. Jackson.

Baugh, Lawrence Marion, Temple, Tex. (Age 28.) Area Engr., Brazos River Conservation & Reclamation Dist. Refers to J. C. Bisset, E. Haquinius, J. A. Norris, E. N. Noyes, C. B. Stanton.

Blair, Robert Collyer, Binghamton, N.Y. (Age 36.) Senior Engr., U. S. Engr. Office. Refers to C. E. Boesch, T. S. Burns, E. L. Daley, F. E. Fahlquist, F. P. Fifer, A. B. Greene, P. F. Kruse, W. R. Vawter, M. J. Young.

Bloodgood, Don Evans, Indianapolis, Ind. (Age 35.) Engr. in charge of sludge filtration, and Plant Mgr. of sewage-and-garbage-disposal plants, Indianapolis Water Co. Refers to H. E. Babbitt, J. L. Ferebee, H. O. Garman, H. S. Morse, L. Pearse, W. Rudolfs, H. W. Streeter.

Bommer, Theodore John, Ann Arbor, Mich. (Age 25.) Graduate student, Univ. of Michigan. Refers to C. E. S. Bardsley, D. C. Bowman, J. B. Butler, W. C. Hoad, W. S. Johnson, H. E. Miller.

Bourgin, Charles Gillman, Montclair, N.J. (Age 31.) Asst. Supt. in charge of Water Bureau, Town of Montclair. Refers to W. R. Conard, A. F. Eschenfelder, J. B. Hayden, S. K. Knox, H. N. Lendall, S. F. Newkirk, Jr., N. Van der Valk, P. S. Wilson.

Brink, Lester Le Roy, Jr., Champaign, Ill. (Age 21.) Refers to J. J. Doland, W. C. Huntington, T. C. Shedd.

Brodrick, Gordon Horth, Cody, Wyo. (Age 24.) Transitman, U. S. Bureau of Reclamation. Refers to R. D. Goodrich, E. K. Nelson, H. T. Person.

Bumstead, John Chambers, Saratoga Springs, N.Y. (Age 25.) Asst. Engr. with S. J. Mott, Civ. Engr. Refers to L. W. Clark, H. O. Sharp.

Cutler, Thomas Henry, Frankfort, Ky. (Age 55.) State Highway Engr., Commonwealth of Kentucky. Refers to C. W. Brown, H. E. Frech, C. W. Lovell, H. D. Palmore, D. V. Terrell, E. C. L. Wagner, W. B. Wendt.

Diamond, Joseph Bertram, New York City (Age 31.) With Dept. of Public Works, City of New York. Refers to R. Cook, W. G. Federlein, J. V. Marra, P. Sander, A. V. Sheridan.

Eliassen, Rolf, Chicago, Ill. (Age 27.) San. Engr., The Dorr Co. Refers to F. Bachmann, T. R. Camp, D. E. Davis, E. L. Mosley, F. G. Nelson, J. C. Pritchard.

Ellis, Benjamin Henry, St. Albans, N.Y. (Age 40.) Gen. Master Mechanic, Dravo Corporation, Neville Island, Pittsburgh, Pa. Refers to A. C. Dennis, J. E. Gibbons, W. Heyman, C. B. Jansen, J. B. Martin, H. L. Muchemore, J. F. Sanborn.

Enright, Paul Manning, Oakland, Calif. (Age 29.) Civ. Engr., Hydr. Dredging Co. Refers to A. J. Ackerman, R. T. Colburn, F. A. Dale, W. S. Hanley, A. M. Komora, H. P. McKean, E. J. Nichols, L. A. Schmidt, Jr.

Evans, Paul Edward, Bishop, Calif. (Age 34.) Jun. Highway Engr., Dept. of Public Works, California Div. of Highways, being Res. Engr. on grading project. Refers to C. E. Arnold, H. P. Cortelyou, M. W. Ellis, R. L. Gregory, M. Harris.

Fenno, Charles Anthony, Jr., Huntington, W. Va. (Age 28.) Jun. Engr., U. S. War Dept. Refers to E. Mirabelli, J. H. C. Sprague.

Frame, Stanley Howard, Victoria, B.C. (Age 60.) Hydr. Engr., Water Rights Branch, Dept. of Lands, Province of British Columbia. Refers to E. E. Carpenter, E. A. Cleveland, A. Griffin, G. M. Irwin, H. B. Muchleston, F. H. Peters, S. G. Porter, R. S. Stockton.

Fuertes Ramirez, Florencio, Mexico City, D. F., Mexico. (Age 38.) Mgr., Ingenieros Constructores, S.A., and Cons. Engr. Refers to J. Chavez-Orozco, F. Gomez-Perez, A. Weiss. (Applies in accordance with Sec. 1, Art. I, of the By-Laws.)

Fulton, Edwin George, Minneapolis, Minn. (Age 38.) Engr. and Contr. at Minneapolis, Minn. and Superior, Wis. Refers to F. Bass,